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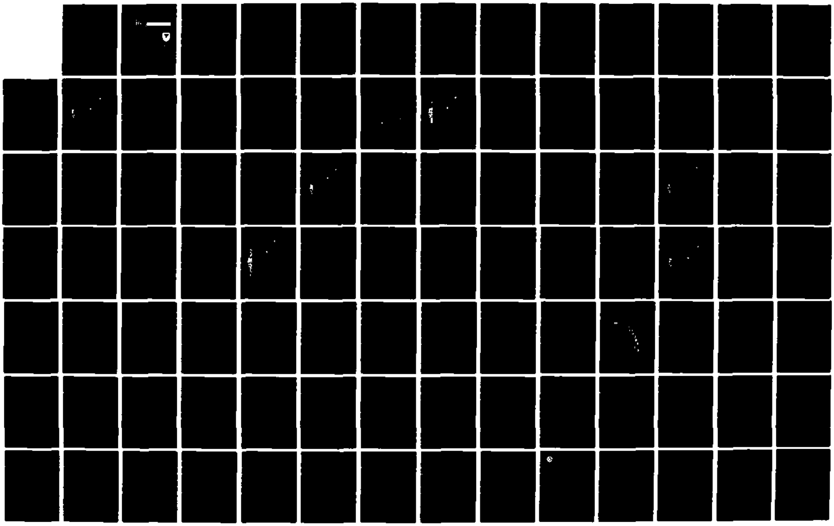

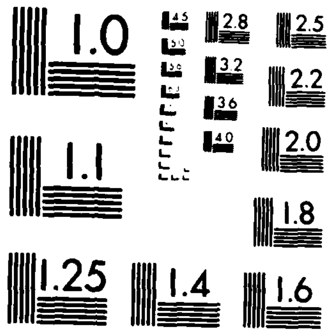

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TECHNICAL REPORT

NO. 13058

MAINTENANCE CONTROL AND
DISPLAY PANEL (MCDP)
CONCEPT FORMULATION
DECEMBER 1984

by MCDP Joint Working Group
JOSEPH W. STEYAERT, Chairman

U.S. ARMY TANK-AUTOMOTIVE COMMAND
RESEARCH AND DEVELOPMENT CENTER
Warren, Michigan 48090

NOTICES

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Diagnostics	ATE	TMDE	Test Requirements
Monitor	BIT	Measurement	Test Concept
Vehicle Test	BITE	Sensors	On-Board Test.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Maintenance Control and Display Panel (MCDP) concept, formulated by an AMC Joint Working Group, is a candidate program for O&S cost reductions. The on-baord diagnostic capability of MCDP is expected to reduce diagnostic and repair time on the M1 Tank in the forward area. Effective implementation would not only reduce mechanic's time to diagnose, it also could reduce logistics requirements in transporting part of the existing test equipment complement forward.

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TABLE OF CONTENTS

BACKGROUND

AMC sent a message (AMCDE SG, DTG 121305Z), subject "Concepts for Maintenance Control and Display Panel (MCDP)" (copy at Addendum 1), requesting that TACOM conduct a Feasibility Evaluation of earlier possible alternatives to Vetronics. The developed concepts would provide a MCDP capability for the M1 and/or a possible retrofit program for Fielded Tanks.

With the TACOM R&D Center taking the lead in this activity, a Joint Working Group (JWG), consisting of elements from AMC, TRADOC, TACOM, CECOM, AVSCOM, AARMC, ORDCENSCH and several contractors, was convened. General Dynamics Land Systems Division (the prime contractor for the M1), RCA/Government Systems Division (diagnostic logic and software developer for M1 on board testing), Chrysler Military Public (developer of a prototype data/power bus distribution system for M1) and Boeing (developer of a MCDP system for the 757/767 aircraft) were selected as contractor representatives for the JWG. The JWG convened on 17-18 October 1984 (minutes included at Addendum 3).

OBJECTIVES

The objectives of the MCDP JWG were four fold:

1. Document the MCDP need/requirement.
2. Determine the level of technical achievability for various MCDP concepts.
3. Develop program schedules for viable MCDP concepts.
4. Estimate upper limits of probable costs.

These objectives, as outlined in this report, have been met and are documented in the following sections.

DISCUSSION

During National Training Center exercizes the commanders observed that when the solider becomes fatiques his ability to use existing intrusive TMDE diminishes. This results in the use of the "swing test" method of fault isolation, instead of automatic test equipment, as the quickest route to repairing the failures. No Evidence of Failure (NEOF) rates have escalated and run 40-60% on the items returned to DS. The two hour support forwawrd doctrinal concept cannot be met

with present systematic TMDE methods and characteristics. TRADOC has issued an assessment of need statement (Addendum 6) that is in consonance with the MCDP concept and philosphy.

The JWG proposed nine concepts or permutations to be considered as a MCDP for M1 support. These concepts are briefly described in this summary and are listed roughly in order from technically least complex to most complex. The Boeing system, as utilized in the 757/767, was not given serious consideration due to its cost (estimated at $500.000 per tank) and the fact that there is no data base system available, or planned for the near future, that would allow the utilization of the off-board data base establishment that is one of the key benefits derived from their version of MCDP. This viewpoint is reiterated in the report from PMCH47 included at addendum 4.

The first concept is an add-on Engine Monitor Module (EMM) consisting of a "smart" data logger with a crew alert panel (to give failure indication) and a maintenance interface unit (to give diagnostic information to the mechanic). The EMM would plug into the Engine Control Unit (ECU) Diagnostic Interface Connector. The technical risk for this concept is low. R&D cost is estimated at $6M with unit cost being approximately $10K per tank. Benefits include on board engine system failure identification and level 1 diagnostics. (Level 1 diagnostics is done entirely through a diagnostic connector with external probing for additional refinements).

The second concept, a permutation of the first, proposes adding transmission monitoring and a prognostics capability to the EMM. With the exception of prognostics, technical risk for this concept is low. Additional R&D cost is estimated at about $600K, primarily for additional test support. Added unit cost is estimated at $6K for transducers, and wiring harnesses. For engine/transmission prognostics a data base would have to be established at an approximate cost of $1M per year for 3-5 years. The technical risk for establishing prognostics is high.

The third concept, also a permutation of the first, puts an EMM device in the turret to monitor and diagnose the stabilization system. Technical risk is moderate. Additional R&D cost (over and above the first concept) is estimated at $3.5M for software validation and verification. An additional year is also required for development. The unit cost grows to $12.5K for the box, if it is to be kept common with the hull systems box. Support costs would be reduced having a common box versus a different type of device for turret and hull.

The fourth concept begins adding technology that enhances vehicle performance as well as giving a MCDP capability. This concept replaces the present ECU with a digital system having the "smart" data logger and monitor function built in. The hardware would be designed with a bus interface to be compatible with the Vetronics system envisioned for the future. Technical risk is low. R&D cost is estimated $10M. The unit cost is estimated at $15K, but the system directly replaces an ECU present costing $10K. Benefits include an

on board engine system failure identification and level one diagnostics. "Soft" failures can also be identified thought the digitized information available. The system is compatible with future improvements (i.e., Vetronics).

The fifth concept, a permutation of concept four, adds a digital Hull Networks Box (HNB) and transmission sensors to the digital ECU. This system gives level one fault diagnostic for engine, transmission and other hull systems as well as providing a potential for prognostics. Additional R&D cost is $600k for test support. Unit cost for the digital HNB and transmission capability adds about $6K. Except for prognostics, this concept has low technical risk. Prognostic application requires establishment of a data base estimated at a cost of $3.5M and requiring about 3 1/2 years for data analysis.

The sixth concept addresses the turret with a "smart" digital diagnostic system. The concept features on board level one diagnostics that includes a "smart" digital stabilization system and fire control computer with built in data log. A data bus structure taking advantage of technology developed with the ATEPS Program is featured. The system also has a new technology commanders panel giving enhanced capabilities. This system is upwardly compatible with the Vetronics architecture presently being developed. Technical risk is moderate. R&D cost is estimated at $3.5M which is basically a PEP program for the ATEPS prototype development. Unit cost is estimated at $46K, but replaces $25K of present hardware and gives enhanced turret functional capability.

The seventh concept involved incorporation of an electronic maintenance manual with any of the above concepts. Although considered to be a valuable aid, the electronic manual is considered impractical for implementation in the short term. It was the JWG consensus that the army needs more than an electronic "page turner" and development of the "right" system of this type requires a long range, and costly, development program beyond the scope of the MCDP project.

The eighth concept involved accelerating the Vetronics program for earlier fielding. Vetronics achieves full system integration for both hull and turret, incorporates the Battlefield Management System (BMS) and provides an on-board diagnostic and prognostic capability. The Vetronics program is optimistically scheduled and involves a "shoot off" among four contractors. Acceleration of this program increases technical risk dramatically and requires a complete revision in development and procurement strategy. Sixteen months is the maximum amount the program could be shortened with an order of magnitude increase in cost. It was unanimously agreed that it is not practical to accelerate this program.

The ninth and final option presented to the JWG was incorporating Vetronics and an autonomous parts requisition system. This concept features all the advantages of Vetronics coupled with a diagnostic/prognostic system capable of ordering replacement parts and scheduling maintenance through an automated

communications link requiring no operator intervention. The technology to develop this system is considered questionable at best and program execution would not be achievable within the short time frame desired for MCDP implementations.

RECOMMENDATIONS

The MCDP JWG in this report presents six viable concepts for MCDP implementation. Any of the first six concepts would be beneficial in maintenance support of the tank.

Add-on hardware (concepts 1-3) appears to be the lowest initial cost type of program and can be implemented in the shortest period of time.

Technology insertion (concepts 4-6), while being more costly, provides more benefits for the vehicle and prepares the electronic subsystems with compatible interfaces for the Vetronics vehicles of the future.

To acquire a MCDP capability on the tank in the shortest possible time the JWG recommends concept 1, the Engine Monitor Module. This concept supports the mobility system which is of utmost importance to the crew. The concept can be expanded to the transmission and other hull systems at any time desired.

If an add-on MCDP is desired for both hull and turret systems, the JWG recommends concept 3A, the Vehicle Monitor Module, which requires more development time but reduces support costs by utilizing hardware identical modules in both hull and turret.

If long term hardware utilization and technology upgrade is a driving factor, the JWG recommends concept 5, the digital ECU, HNB and transmission monitoring system. This technology insertion assures use of the digital hardware during the Vetronics era through incorporation of the 1553 bus.

The JWG also recommends concept 6, the digital stabilization system, turret networks box and commander's panel with associated bus structure as a technology insertion that fits with the M1 Block II Mod. Implementation of Concept 6 with its associated 1553 bus structure allows direct implementation of the Battlefield Management System (BMS) module scheduled approximately 1 year after the Block Mod. Vetronics hardware, when available, could also be integrated on the same bus structure.

Program Assumptions

The clock on the schedule starts at award of contract. Government administrative lead time for contract preparation and award is not included.

Administrative lead time to award on MCDP contract could range from 154 days to 240 days depending on procurement method.

Schedule does not consider activities for implementation into vehicle production which must be coordinated between vehicle manager and prime contractor. Program schedule and costs only go to MCDP production availability for inclusion on the vehicle by direction to vehicle production, retrofit or depot stock.

The MCDP concept selected should be nuclear hardened to the same requirements as are presently incorporated in the M1 Tank or, for a minimum acceptable approach, must not detract from the present nuclear hardening capabilities of the Tank if for any reason the full requirement for a nuclear hardened MCDP is waived.

No requirement document is required for MCDP.

There would be no need to retypeclassify the tank just for inclusion of a MCDP. User must place a high priority on MCDP if the concept is to succeed.

Schedules assume immediate availibility of funding.

Failure of MCDP sensors will not cause vehicle secondary failures or cause the vehicle to loose functionality.

Regardless of concept chosen, the MCDP will be user friendly for maintenance personnel.

The equipment must be an effective aid to troubleshooting, but will not be required to fault diagnose to the piece part in all cases.

The MCDP would have the same type of service support requirements as the equipment that it replaces.

The MCDP would be equipped with some sort of self test capability.

Development of MCDP system specification is a separate effort, having some cost impact, that must be completed prior to competitive contract action.

MCDP will save diagnostic time through a continuous monitoring of all level 1 diagnostic routines - Level 2 diagnostic requirements will remain unchanged.

MCDP CONCEPT 1

ENGINE MONITOR MODULE (EMM)

(ADD-ON HARDWARE)

TECHNICAL DESCRIPTION
ENGINE MONITOR MODULE (EMM)

The Engine Monitor Module (EMM) is a small, easily installed turbine engine system monitor with the capability to provide instant diagnosis of engine system faults. The EMM is a general purpose add-on device with crew and maintenance displays which does not affect the operation of the M1 vehicle.

Engine system control and status signals from the electronic fuel control, driver's master panel, driver's instrument panel, and the hull networks box are continuously monitored by the EMM and compared with acceptable levels. Abnormal signal levels, including intermittent faults, trigger the EMM diagnostic process. Engine signal levels during and prior to a fault are examined automatically to isolate the problem to a specific engine subsystem, i.e starter, ignition, fuel delivery. Fault diagnostics is performed instantly and automatically.

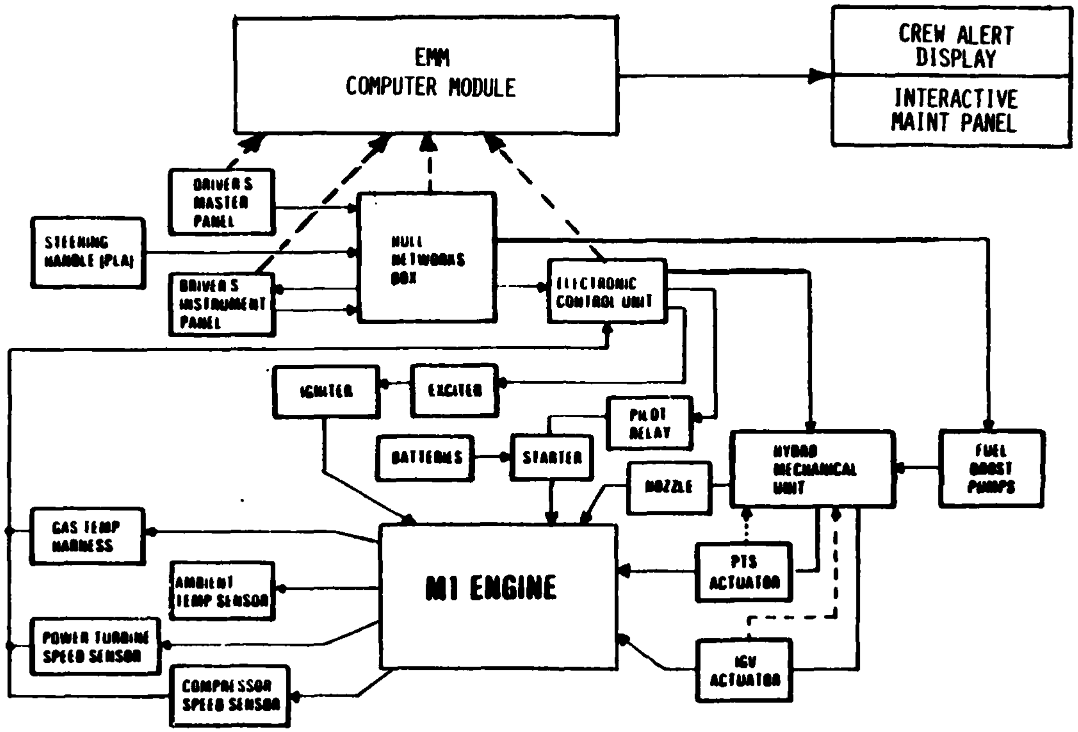
A crew alert display would provide the crew with optional engine operating suggestions. An interactive maintenance panel or set communicator would display troubleshooting messages which identify the faulty subsystem and direct organizational maintenance personnel to the proper component isolation and repair procedures. The primary objective of the FMM is to provide built-in diagnostics to a level such that simple field equipment, like a multimeter, is all that is required to quickly isolate the problem to the faulty component

Other features of the EMM include the capability to enable organizational maintenance to trim the electronic control unit and adjust the linkages of the mechanical engine controls without additional test equipment. The engine system performance level will be periodically determined and stored for off-line analysis of performance trends. Typical prognostic data, such as engine temperature and speed stress cycles, will be stored for off-line analysis to eventually predict component failure

The benefits to crew, maintenance, and supply are substantial. Troubleshooting will be more accurate, penetrating deeply into the "no evidence of failure" (NEOF) problem and the unnecessary expansion of component inventories. Troubleshooting time will be much less - minutes instead of hours - and will provide the opportunity to achieve the "2 HOUR FIX FORWARD" maintenance concept mandated for battlefield conditions. Finally, then EMM will provide a rapid assessment of vehicle mobility to aid in expediting repairs.

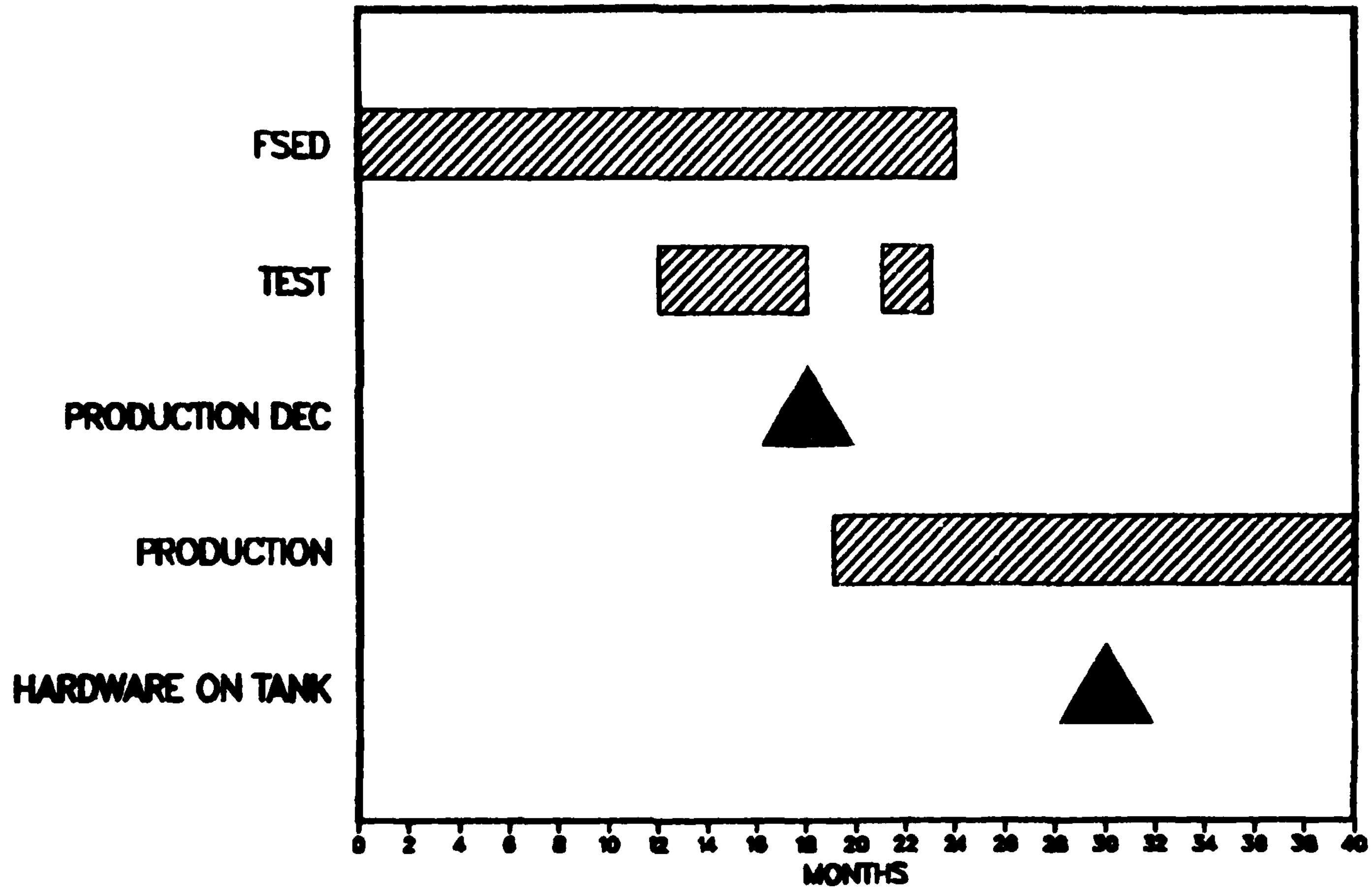
The technology required to accomplish the on-board diagnostic task is not new. An engineering model engine signal monitor, developed and mounted aboard 2 M1 vehicles, has successfully demonstrated the feasibility of monitoring and storing critical engine signals for diagnostic analysis. TACOM has also used a similar device for data gathering for prognostic technology.

Technical risk for EMM development is considered low.



ENGINE MONITOR MODULE
INTERCONNECT

SCHEDULE
MCDP CONCEPT 1
ENGINE MONITOR MODULE-EMM



COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 1 Engine Monitoring Module (EMM)

DEVELOPMENT

24 months effort	6000K
UNIT HARDWARE COST[2]	10K/VEH

NOTES

1 Unvalidated, Preliminary Engineering Estimate of Upper Level of Costs, Source MCDP JWG Oct 84 and AMSTA-RGDD Nov 84.

2 Based on Quantity of 1000 units.

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MCDP CONCEPT 2

ENGINE MONITOR MODULE PLUS TRANSMISSION MONITORING AND PROGNOSTIC CAPABILITY

(ADD-ON HARDWARE)

TECHNICAL DESCRIPTION
ENGINE MONITOR MODULE WITH TRANSMISSION MONITORING AND PROGNOSTIC CAPABILITY

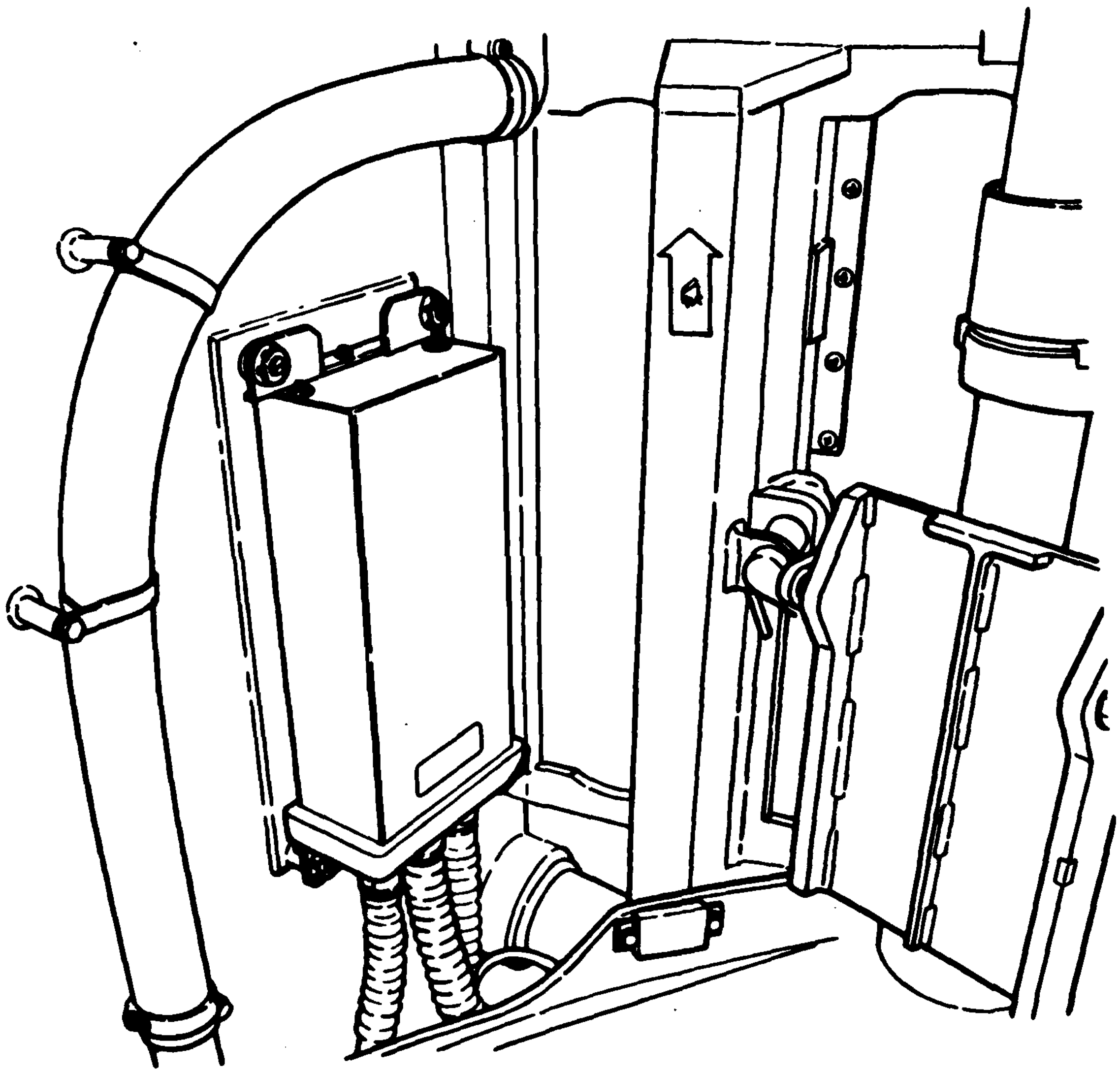
Transmission diagnostics capability can easily be incorporated into the EMM concept by permanently inserting sensors into existing transmission parts, adding the transmission diagnostic wiring harness and making provisions in the EMM hardware and software interfaces.

To be technically viable and cost effective the transmission requirement must be an "up front" requirement rather than an "add-on" later in the program. Interface provisions must be developed early in the program, to allow the EMM to accept data from multiple sources.

Incorporation of prognostics would require a minimum of 3 1/2 years of field experience (on - vehicle data acquisition) with the EMM. A large data base must be established and a data analysis program developed at a computer facility.

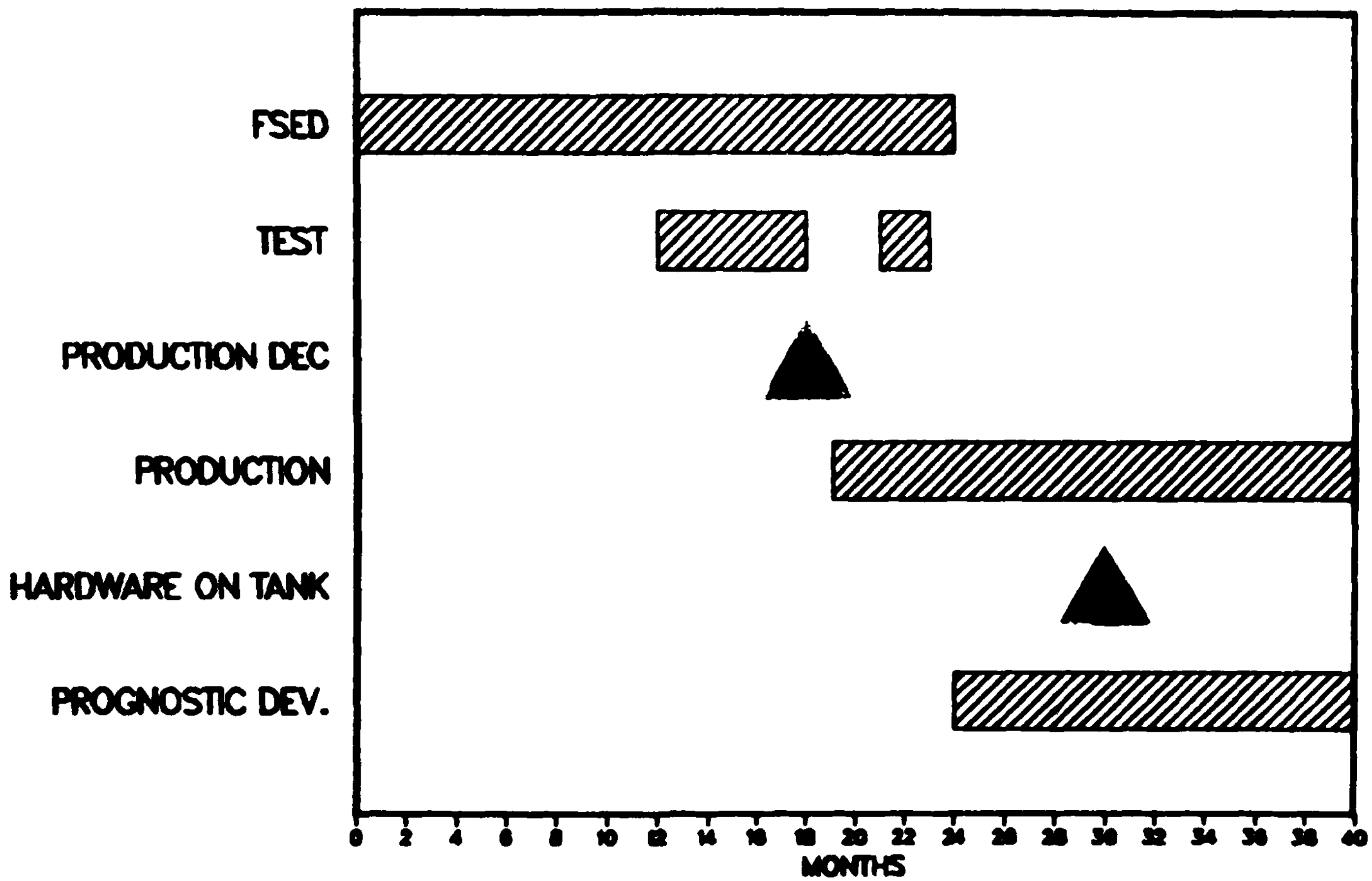
Prognostics would be implemented as soon as valid algorithms are developed. Expansion of the prognostic capability would continue throughout the life cycle of the vehicle and EMM.

Technical risk for EMM development with transmission capability is considered low. Technical risk for establishment of a prognostics capability is considered high.



EMM - COMPUTER MODULE

SCHEDULE
MCDP CONCEPT 2
ENGINE MONITOR MODULE-EMM
PLUS TRANSMISSION MONITORING AND PROGNOSTICS



COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 2 — Engine Monitoring Module (EMM)
+ Transmission Monitoring Kit
+ Prognostic Capability (Optional)

DEVELOPMENT:

EMM	24 months effort	6000K
+ Transmission	24 months effort	600K
Subtotal		6600K
+ Prognostic Capability	42 months effort	3500K
TOTAL		10,100K

UNIT HARDWARE COST[2]

EMM	10K/Veh
Transmission Monitoring Kit	6K/Veh
TOTAL	16K/Veh

NOTE:

1 Unvalidated, Preliminary Engineering Estimate, Upper Level of Cost Source: MCDP JWG Oct 84 and AMSTA-RGDD Nov 84.

2 Based on Quantity of 1000 Units.

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MCDP CONCEPT 3

TURRET MONITOR MODULE (TMM)

(ADD-ON HARDWARE)

TECHNICAL DESCRIPTION

TURRET MONITOR MODULE (TMM)

The Turret Monitor Module (TMM) is a small, easily installed fire control systems monitor with the capability to provide instant diagnosis of system faults. The TMM, an expanded version of the Engine Monitor Module (EMM), consists of an electronics module and a gunner's display panel and, similarly, does not affect the operation of the vehicle or fire control system.

The TMM will continuously monitor fire control system function signals during normal operation and compare them with acceptable levels. Abnormal signal levels will trigger the automatic diagnostic process and the gunner's display panel will indicate that a fault has occurred and which functional subsystem is involved

Further isolation is achieved when the crew activates the fire control computer self-test. The self-test verifies the existance of the faulty condition and permits the TMM to check the proper function of each of the major interacting fire control components. The gunner's display panel will then indicate either the faulty component for replacement or the component and cables group that requires additional isolation. If additional isolation is needed, the TMM will reference and/or display the appropriate follow-on troubleshooting procedures.

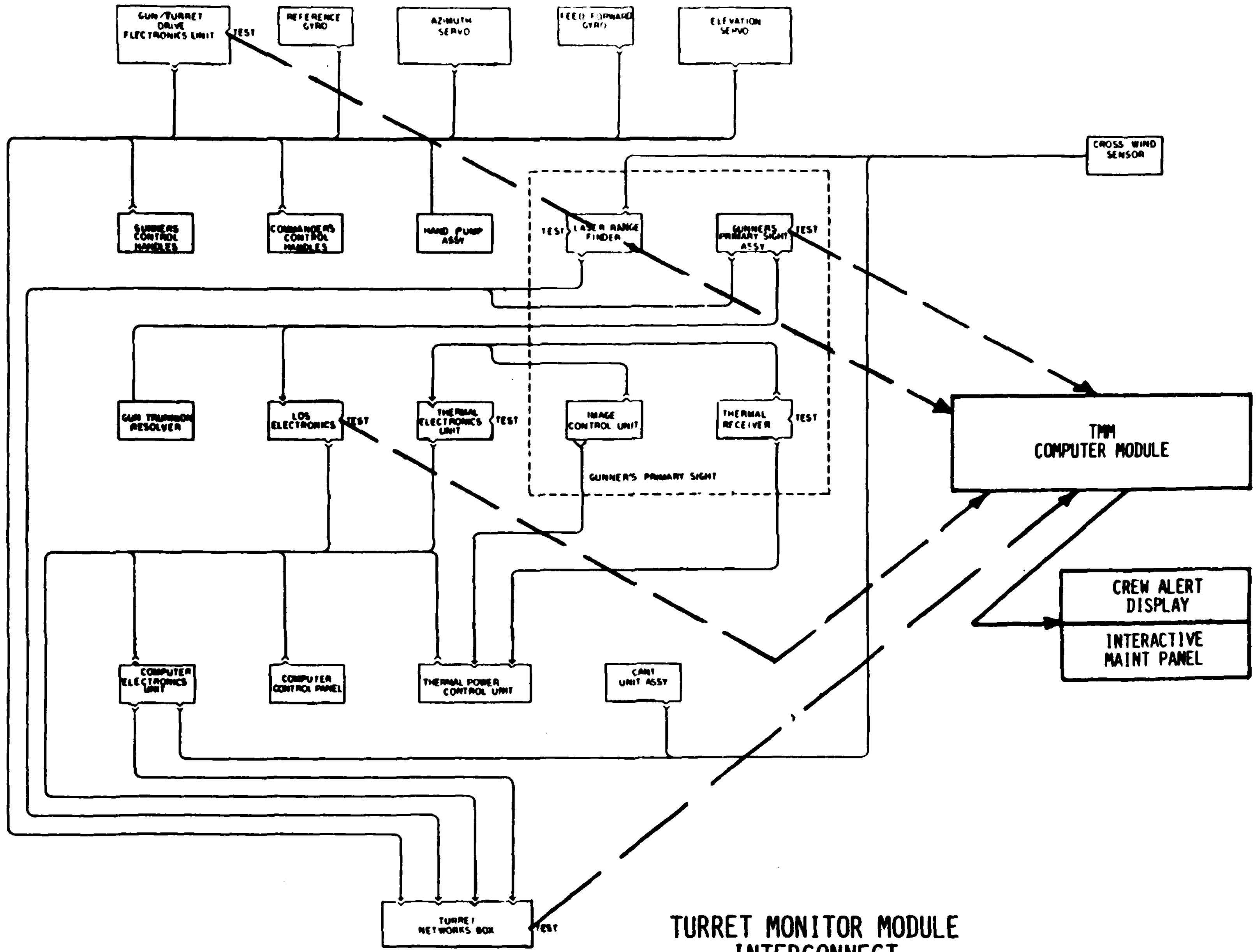
The primary objective of the TMM is to provide built-in diagnostics to a level such that either the faulty component is identified or that simple field equipment, such as a multimeter, is all that is required to isolate to the faulty component or cable.

The fire control hydraulic system performance level will be periodically determined and stored for off-line analysis of performance trends. Limited prognostics data related to fire control system operation will be stored for off-line analysis to eventually predict component failure.

The technology required to accomplish the on-board diagnostic task is not new. An engineering model engine signal monitor, developed and mounted on 2 M1 vehicles has successfully demonstrated the feasibility of monitoring and storing critical vehicle signals for diagnostic analysis.

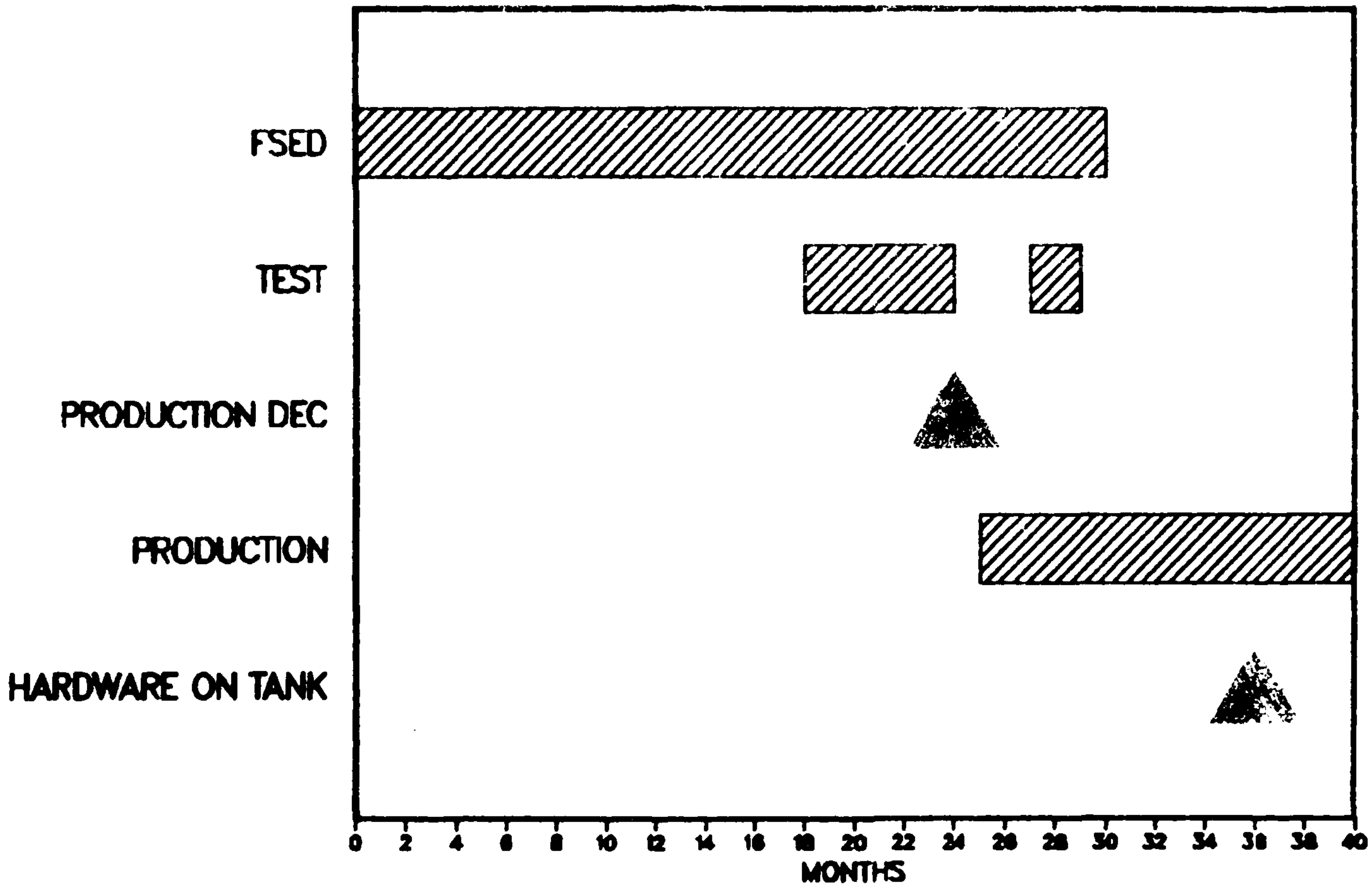
The benefits to crew, maintenance, and supply are substantial. Troubleshooting will be more accurate, penetrating deeply into the "no evidence of failure" (NEOF) problem and the necessary expansion of component inventories. Troubleshooting time will be much less - minutes instead of hours - and will provide the opportunity to achieve the "2 HOUR FIX FORWARD" maintenance concept mandated for battlefield conditions. Finally, the TMM will provide a rapid assessment of the fire control system to perform its mission.

Technical risk for the TMM development is considered low.



TURRET MONITOR MODULE INTERCONNECT

SCHEDULE
MCDP CONCEPT 3
TURRET MONITOR MODULE-TMM



COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 3   Turret Monitoring Box (TMB)

DEVELOPMENT:

30 months effort	9,000K
UNIT HARDWARE COST[2] TMD	10K/Veh

NOTES:

[1] Unvalidated, Preliminary Engineering Estimate, Upper Level of Cost Source: MCDP OCt 84 and AMSTA-RGDD Nov 84.

[2] Based on Quantity of 1000 units.

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MCDP CONCEPT 3A

VEHICLE MONITOR MODULE (VMM)
FEATURING THE IDENTICAL MODULE
FOR BOTH HULL AND TURRET MONITORING

TECHNICAL DESCRIPTION

VEHICLE MONITOR MODULE (VMM)

The vehicle Monitor Module (VMM) is a small, dual purpose, system monitor/diagnostic unit that can be easily installed in the hull as an engine system monitor and in the turret as a fire control system monitor. The VMM hardware, electronics module and display, is common to both applications. Software and cables are peculiar to each

Two VMM units will simultaneously monitor the engine system and fire control system signals and compare them with acceptable levels. Abnormal signal levels including intermittent signals will trigger the automatic VMM diagnostic process. Display panels, located in the hull and turret, will indicate that a fault has occurred and indicate which subsystem is involved.

ENGINE

Engine signals during and prior to a fault are examined to isolate the problem to a specific engine subsystem, i.e. starter, ignition, and fuel delivery. Fault diagnostics is performed instantly and automatically. A crew alert display provides the crew with optional engine operating suggestions. An interactive maintenance panel or set communicator displays trouble-shooting messages which identify the faulty subsystem and directs organizational personnel to the proper component isolation and repair procedures.

Other features of the VMM include the capability to trim the electronic fuel control unit and adjust the linkages of the mechanical engine controls without additional test equipment. The engine system performance level will be periodically determined and stored for off-line analysis of performance trends. Typical prognostic data, such as engine temperature and speed stress cycles, will be stored for off-line analysis to eventually predict component failure.

Transmission diagnostics capability can be easily be incorporated into the EMM by permanently inserting a few sensors in existing transmission parts.

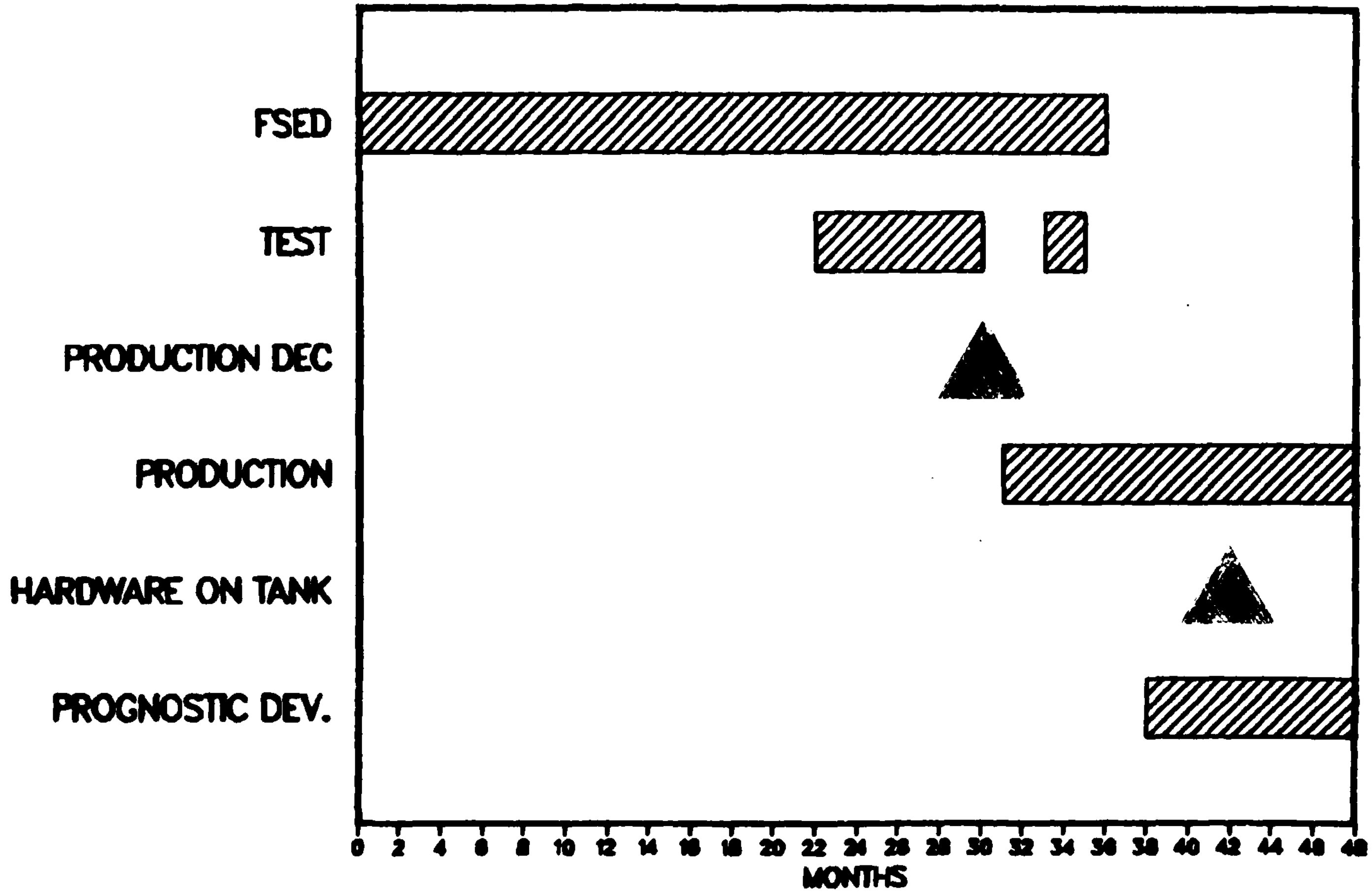
TURRET

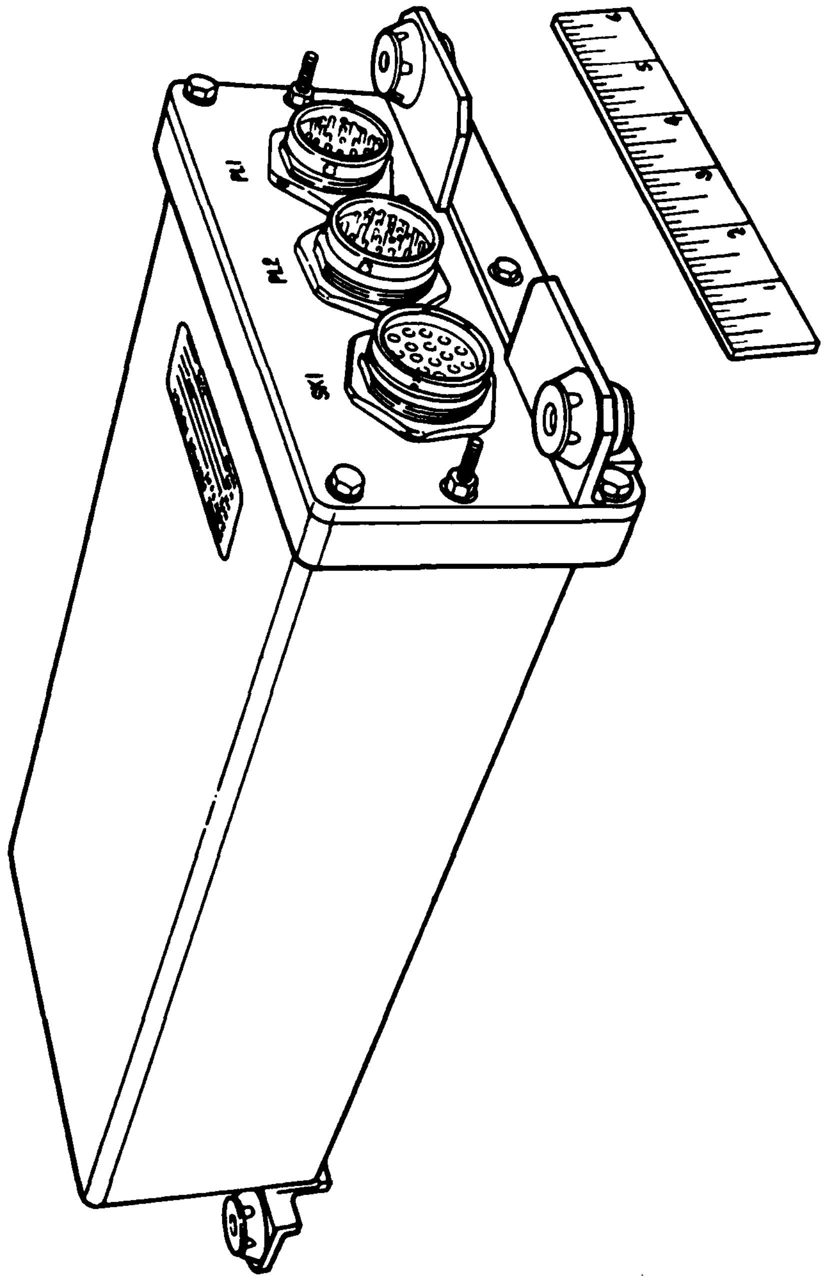
Further fault isolation is achieved when the crew activates the fire control computer self-test. The self-test verifies the existance of the faulty condition and permits the VMM to check the proper function of each of the major interacting fire control components. The common display panel will then indicate either the faulty component for replacement or the component and cables group that requires additional isolation. If additional isolation is needed, the VMM will reference and/or display the appropriate follow-on troubleshooting procedures.

The fire control hydraulic system performance level will be periodically determined and stored for off-line analysis of performance trends. Limited prognostics data related to fire control system operation will be stored for off-line analysis to eventually predict component failure or need for adjustment.

Technical risk for VMM development is considered low. Technical risk for establishment of a prognostic capability is considered high.

SCHEDULE
MCDP CONCEPT 3A
VEHICLE MONITOR MODULE





COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 3A   Turret Monitoring Module
+ Engine Monitoring Module
+ Transmission Kit

DEVELOPMENMT:

	42 months effort	10,000K

UNIT HARDWARE COST[2]

	Turret	10K
Same Box	Engine	10K
	Transmission	6K
	TOTAL	26K

NOTES:

[1] Unvalidated, Preliminary Engineering Estimate of Upper Level of Case Source: MCDP JWG Oct 84 and AMSTA-RGDD Nov 84.

[2] Based on Quantity of 1000 Units

MCDP CONCEPT 4

DIGITAL ENGINE CONTROL UNIT (ECU) WITH MONITOR CAPABILITY

(TECHNOLOGY IMPLANT)

TECHNICAL DESCRIPTION

Digital Electronic Control Unit (DECU)

The DECU alternative involves the replacement of the existing Engine Control Unit (ECU) with a full authority DECU and a built-in-test/monitor (BIT/M) panel. The DECU will provide the full functionality of the current ECU while also providing a significant level of diagnostic and prognostic capability on board the vehicle. The BIT/M panel will complement the diagnostic and prognostic features of the system by providing an interactive display/query device for presentation of diagnostic/prognostic, and repair information.

Some of the key features which the DECU provides are:

Full digital engine control including all protective modes and automatic start-up and shut-down. Full interface to the existing engine electro-mechanical fuel system and other relevant elements.

Diagnostic measurements and conclusions with interactive instruction for any operator assisted actions (as in arranging a specific operational state or temporary cable disconnection) to permit identification of faulty cables and boxes. This test capability will isolate 73 percent of the engine and 14 percent of other hull system faults which are diagnosed by STE-M1/FVS.

Prognostic measurements and conclusions tracking engine and engine-accessory degradation (including batteries).

Timely caution and warning messages to the operator based on the diagnostic/prognostic conclusions.

Information on repair requirements, work-around expedients and mission impact.

Repository of diagnostic/prognostic data and conclusions for later retrieval and off-board analysis.

Full self-test capability of the DECU and BIT/M.

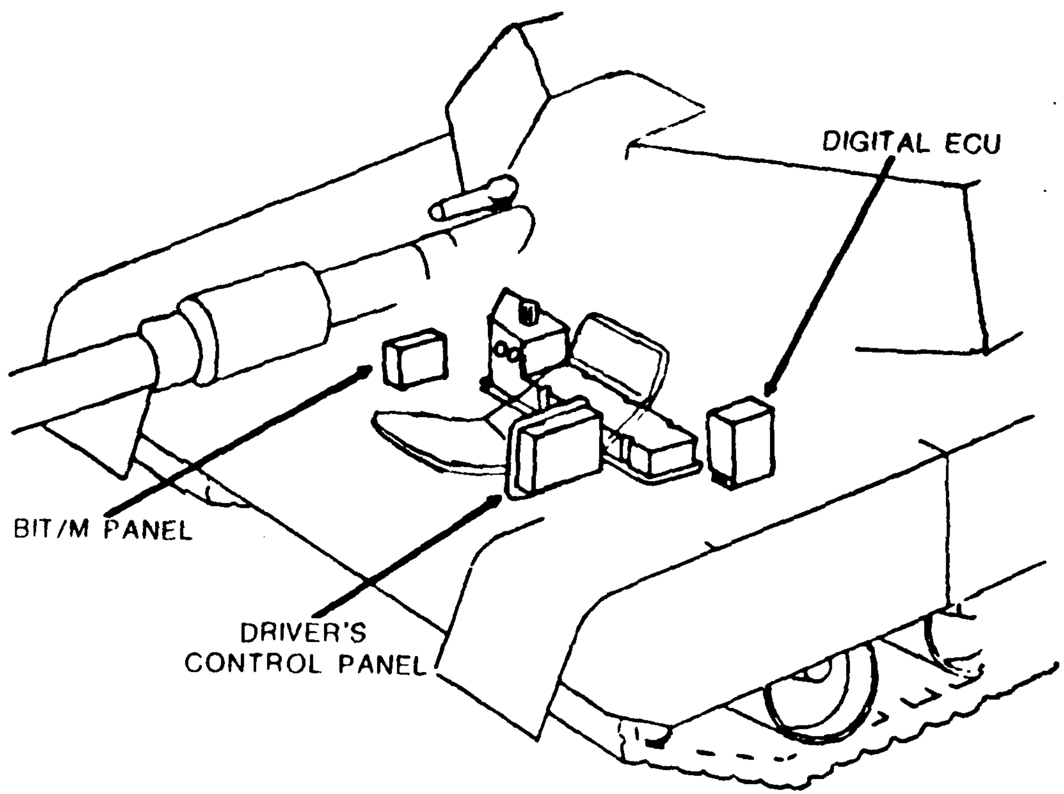
Bus interface to the BIT/M which is compatible with other future M1 improvements in a Vetronics environment.

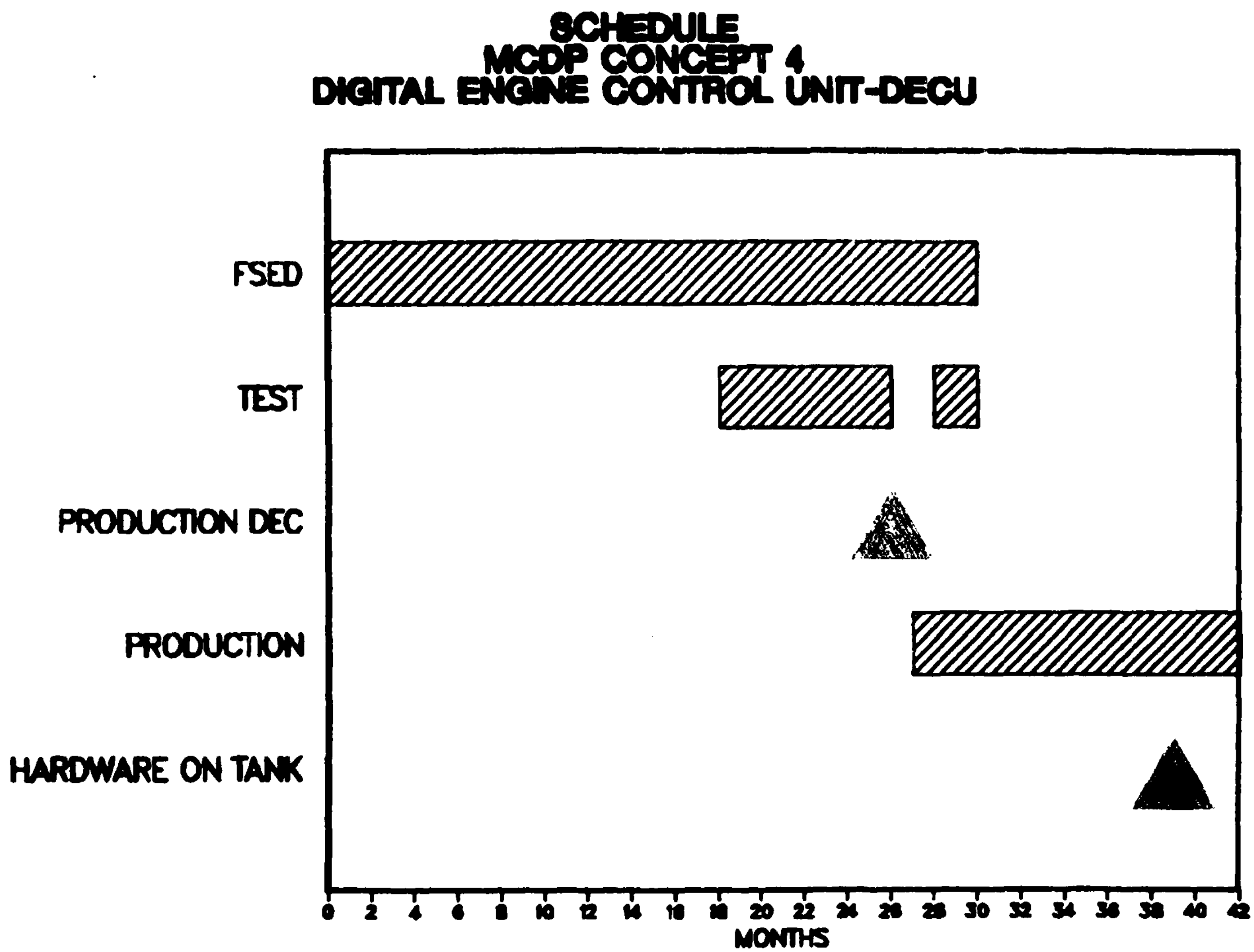
The DECU retrofit can be implemented with minimal impact on the vehicle, making maximum use of existing vehicle cables and mounting provisions.

Technical risk for DECU development is considered low. Technical risk for establishment of a prognostic capability is considered high.

FIGURE 1
BUILT-IN DIAGNOSIS AND PROGNOSIS
FOR THE M1

- CAPABILITIES FOR ENGINE AND HULL SYSTEMS
  - BIT/MONITORING
  - PROGNOSIS
  - ALARMS/ALERTS
- RETROFITTABLE TO EXISTING FLEET
  - USES EXISTING CABLES/MOUNTS
- FIELD REPROGRAMMABLE
- VETRONICS COMPATIBLE




SCHEDULE
MCDP CONCEPT 4
DIGITAL ENGINE CONTROL UNIT-DECU
FSED
TEST
PRODUCTION DEC
PRODUCTION
HARDWARE ON TANK
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
MONTHS

COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 4 Digital Engine Control Unit (ECU)

DEVELOPMENT:

30 month effort	10,000K

UNIT HARDWARE COST[2]

15K/veh Digital ECU
- 10K (less Existing Analog ECU)
5K Net, Production Vehicles

NOTES:

[1] Unvalidated, Preliminary Engineering Estimate of Upper Level of Cost
Source: MCDP JWG Oct 84 and AMSTA-RGDD Nov 84.

[2] Based on Quantity of 1000 units.

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MCDP CONCEPT 5

DIGITAL ENGINE CONTROL UNIT (ECU), HULL
NETWORKS BOX (HNB) WITH TRANSMISSION
SENSORS AND DRIVERS CONTROL PANEL (DCP)

(TECHNOLOGY IMPLANT)

TECHNICAL DESCRIPTION

DIGITAL ENGINE CONTROL UNIT (DECU), HULL NETWORKS BOX (HNB) WITH TRANSMISSION SENSORS AND DRIVERS CONTROL PANEL (DCP)

An enhancement to the previous concept replaces the Hull Networks Box (HNB) with a unit similar to that demonstrated in the ATEPS hull system. This incorporates with the digital ECU and the built-in test/monitor (BIT/M) panel function becomes part of the Drivers Control Panel (DCP) which replaces both the DIP and DMP. This concept was also demonstrated in the ATEPS hull system.

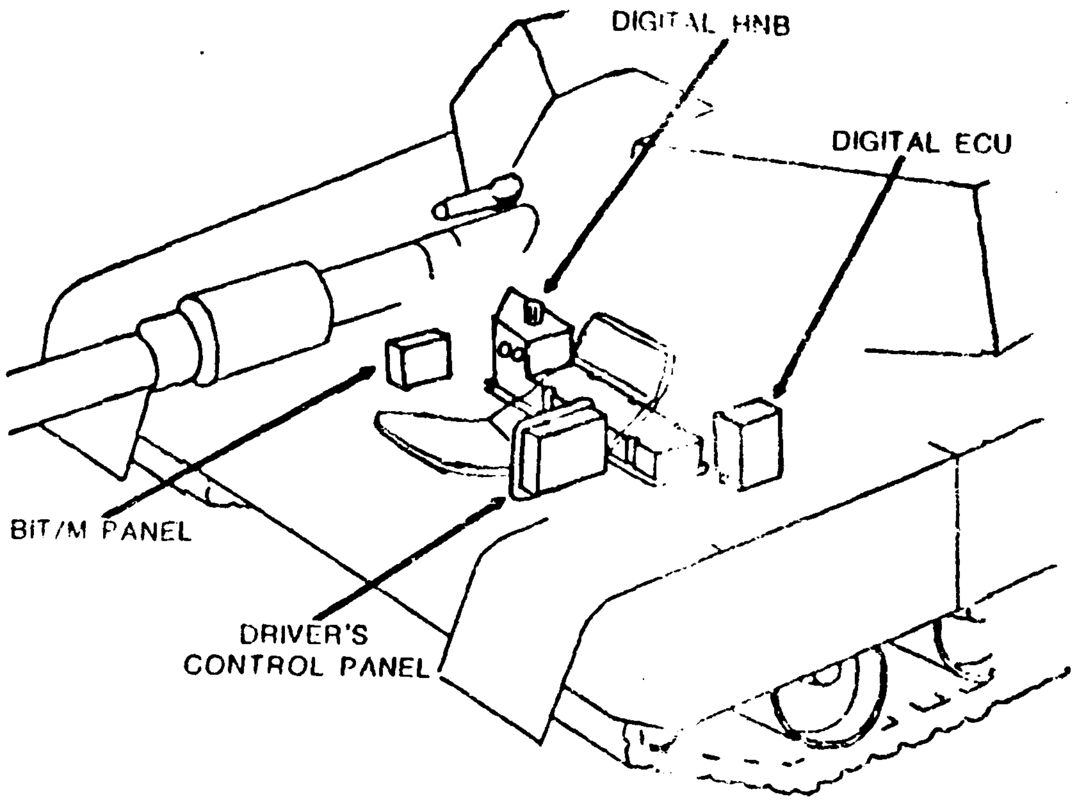
This concept projects an expansion of test and prognosis capabilities, improvement in information available to the vehicle crew, and thus, promises increased vehicle readiness potential.

Incorporation assures major improvement in diagnostic capabilities for the most hull components of any previously proposed built-in test system.

Technical risk for the development of DECU, HNB and DCP is considered low. Technical risk for the incorporation of prognostics is considered high.

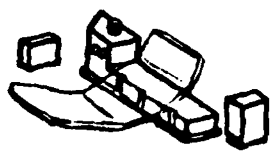
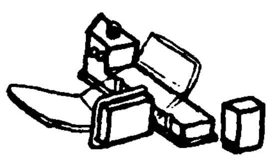
FIGURE 1A
BUILT-IN DIAGNOSIS AND PROGNOSIS
FOR THE M1

- o CAPABILITIES FOR ENGINE AND HULL SYSTEMS
  - BIT/MONITORING
  - PROGNOSIS
  - ALARMS/ALERTS
- o RETROFITTABLE TO EXISTING FLEET
  - USES EXISTING CABLES/MOUNTS
- o FIELD REPROGRAMMABLE
- o VETRONICS COMPATIBLE



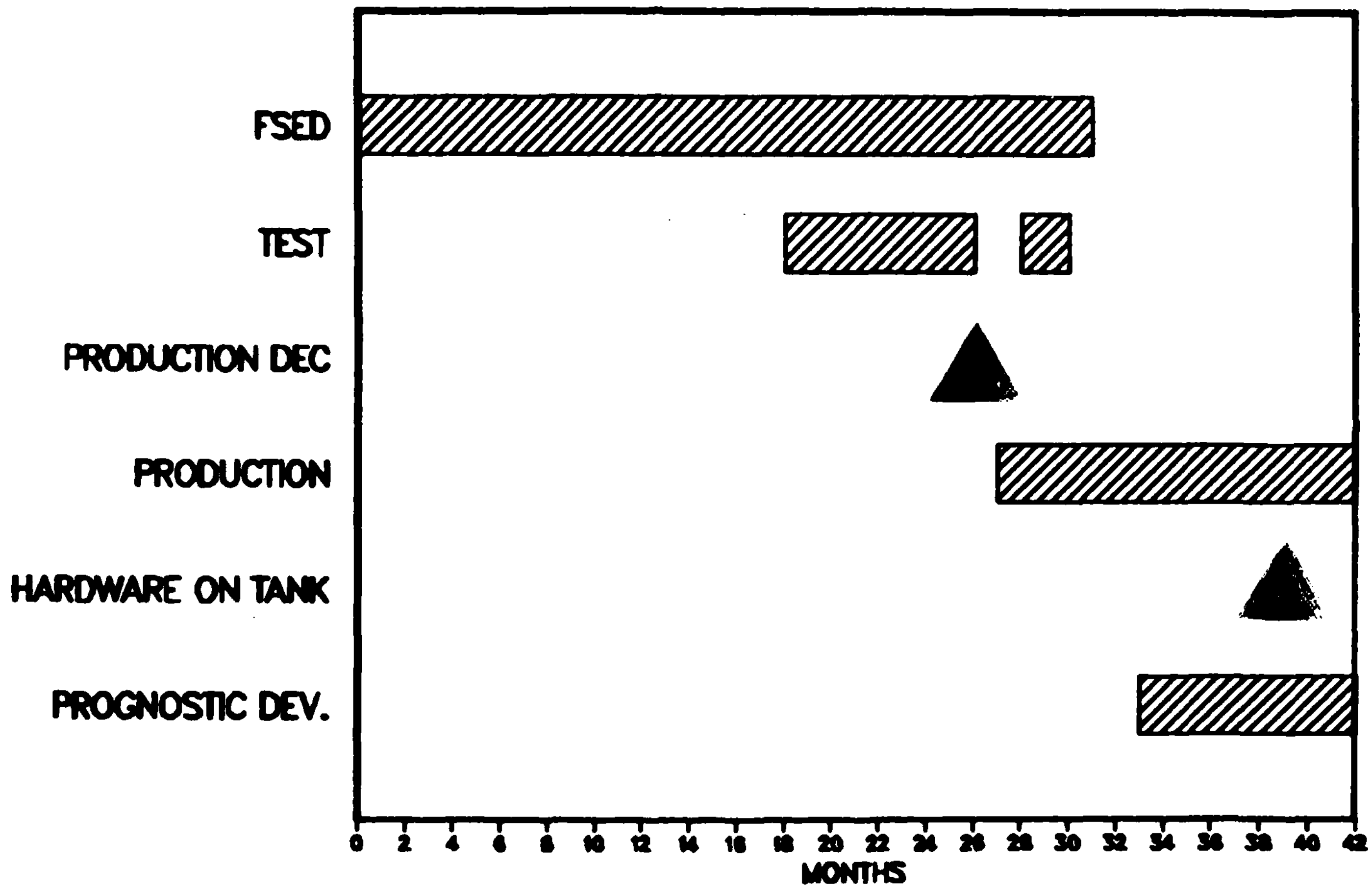
M1 HULL SYSTEM COVERAGE BY

BUILT-IN DIAGNOSIS AND PROGNOSIS

APPROACH			% COVERAGE*	
			ENGINE	OTHER HULL SYSTEMS
DECU		DETECTABLE	100	14
		ISOLATABLE	73	14
DECU + HNB		DETECTABLE	100	65
		ISOLATABLE	92	53
DECU + HNB + DCP		DETECTABLE	100	74
		ISOLATABLE	94	61

*AS A % OF DIAGNOSTICALLY UNIQUE CONCLUSIONS REACHED BY STE-M1/FVS

SCHEDULE
MCDP CONCEPT 5
DIGITAL ENGINE CONTROL UNIT-DECU, HULL NETWORKS BOX-HNB AND DRIVERS CONTROL PANEL-DCP



COST SUMMARY SHEET[1]

(\$FY85 CONSTANT)

CONCEPT 5 Digital Engine Control Unit (ECU)
+ Hull Networks Module (HNM)
+ Prognostic Capability (Optional)

DEVELOPMENT

	Digital ECU + HNM	10,000K
-	Transmission Sensors	600K
	Subtotal 39 month effort	10,000K
+	Prognostics Capability 42 month effort	3,500K
	TOTAL	14,100K

UNIT HARDWARE COST[2]

	Digital ECU (including HNM)	15K
	less existing Analog ECU	10K
	NET	5K
+	Transmission Sensors	6K
	TOTAL	11K

NOTES:

1 Unvalidated Preliminary Engineering Estimate of Upper Level of Cost Source: MCDP JWG Oct 84 and AMSTA-RGDD Nov 84.

2 Based on Quantity of 1000 Units.

MCDP CONCEPT 6

DIGITAL STABLIZATION SYSTEM, TURRET NETWORKS
BOX AND COMMANDERS PANEL
INTERCONNECTED WITH DATA BUS STRUCTURE

(TECHNOLOGY INSERTION)

TECHNICAL DESCRIPTION

DIGITAL STABILIZATION SYSTEM, TURRET NETWORKS BOX AND COMMANDERS PANEL INTERCONNECTED WITH A DATA BUS STRUCTURE

The reliability, maintainability and testability of the turret portion of the M1 Abrams Tank can be enhanced by installing a MIL-STD-1553B data bus in the turret and developing compatible Line Replaceable Units (LRUs) that make maximum use of ATEPs technology. In so doing, the following LRUs will be replaced with digital equivalents:

(1) Gun Turret Drive-Electronics Unit (GTD-EU)

(2) Turret Networks Box (TNB), and

(3) Commander's Control Panel (CCP).

The GTD-EU will be replaced by a digital turret stabilization terminal (TST-EU) similar to the one previously designed, fabricated, tested, and installed on an M1 tank during the course of the ATEPS turret program. This digital stabilization terminal will replace the existing GTD-EU in form, fit, and function, and will incorporate built-in test (BIT) and built-in test equipment (BITE). The new TST-EU will contain built-in test features for the entire turret stabilization system and will reduce the Simplified Test Equipment (STE) test requirements in this area by approximately 80%. Additionally, any manufacturing engineering or performance changes to the turret portions of the M1 Abrams Tank will only require changes to the software code embedded in the digital turret stabilization terminal electronics unit .

The existing Turret Network Box (TNB) will be replaced by a digital equivalent that will be form, fit, and function compatible to the present TNB, and will incorporate built-in test (BIT) and build-in test equipment (BITE) with a MIL-STD-1553 bus compatible design. The digital TNB will contain extensive BIT and BITE to fault isolate itself and will also provide backup MIL-STD-1553 bus control capability. The MIL-STD-1553 bus interface will also provide the means by which the commander will have control of the turret power distribution via his display/control panel.

The existing Commander's Terminal that includes a flat panel display with a programmable touch sensitive overlay. This arrangement allows display of up to 1200 alphanumeric characters and/or 20 discrete push buttons per display page with several hundred pages available in program memory. Similar hardware is presently being developed under TACOM's Advanced ATEPS program and is targeted for installation and test in a prototype M1 Abrams Tank in December 1984. The features of this new unit will also provide the commander with significantly more information and control than he presently has, and provide the extensive diagnostic and BIT and BITE to fault isolate with the commander's terminal. The new commander's terminal will have the memory capacity to provide maintenance personnel with significant amounts of maintenance

troubleshooting guides. schematics, block diagrams, flow charts and the like. A standard video port will also be provided and real time, remote, or stored video images can be displayed on the electroluminescent flat panel.

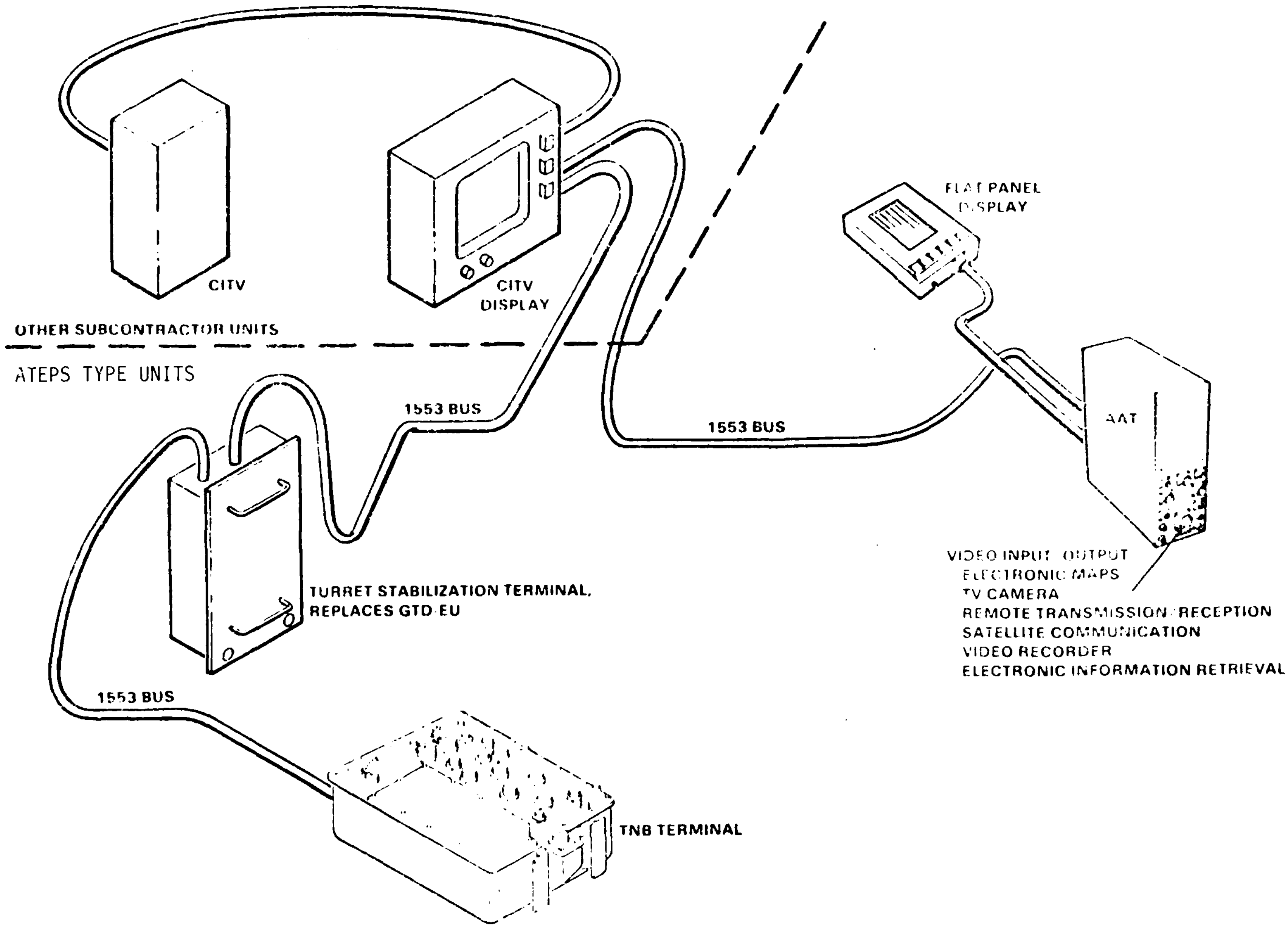
The proposed MIL-STD-1553 data bus system and associated digital LRUs will interface electrically to the Commander's Independent Thermal Viewer Subsystem (CITV) proposed for M1E1 Block II program via the MIL-STD-1553B port. The data bus system can also be implemented as a whole as proposed, or it can be implemented incrementally, which is a significant feature of a data bus system.

Since similar prototype hardware is available for demonstration through the ATEPS program, technical risk for this development is considered to be low to medium

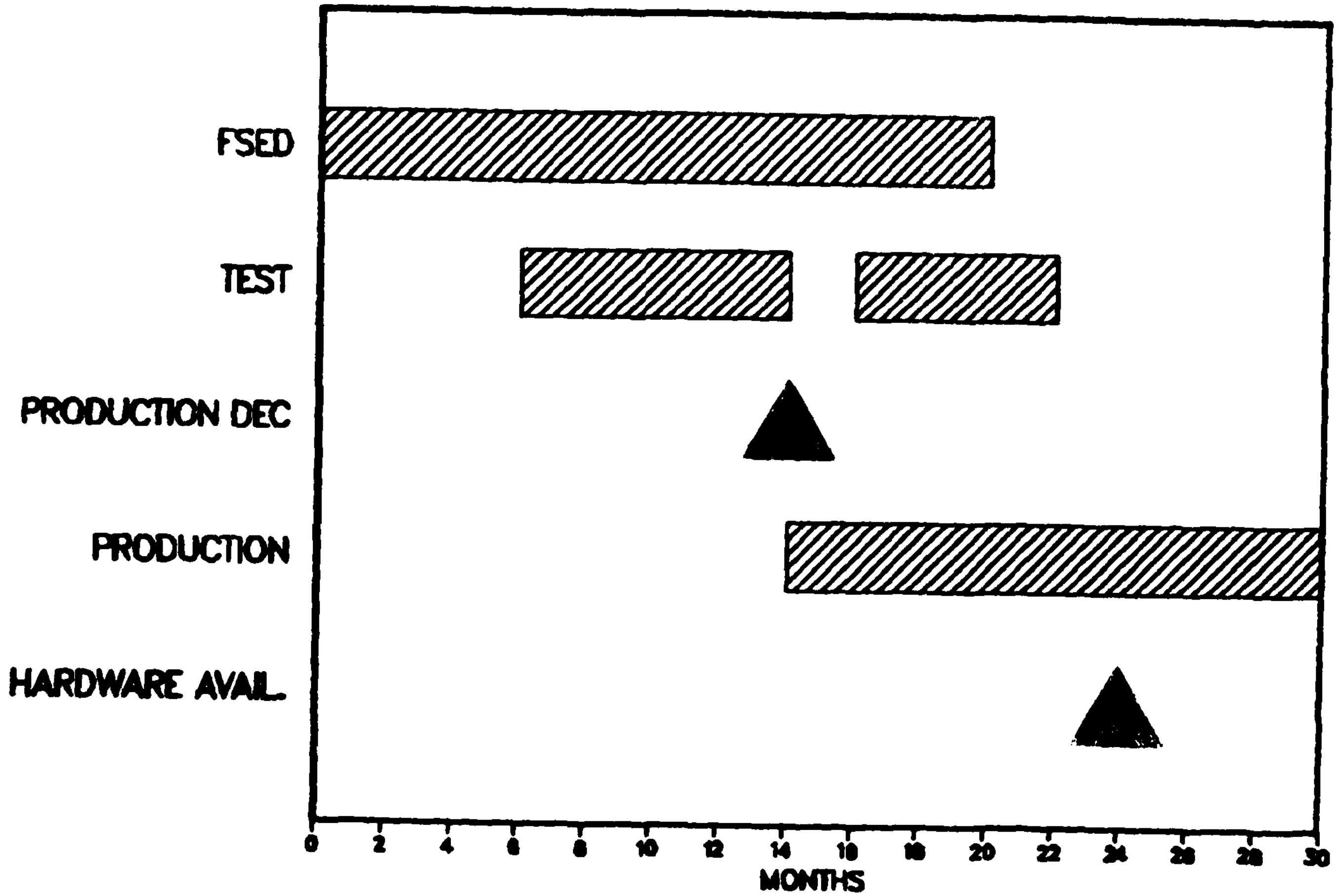
STABILIZATION SYSTEM TEST COMPARISON

TEST ITEM	STE-M1	TST-EU BIT
CMDR Handles	Yes	Yes
GNR Handles	Yes	Yes
EL Ref Gyro	Yes	Yes
EL F.F. Gyro	Yes	Yes
El 3rd Stage Xducer	Yes	Yes
EL Diff. Press. Xducer	Yes	Yes
Sight/Gun Error Sig.	Yes	Yes
El Servo Valve	Yes	Yes
Trav. Rate Gyro	Yes	Yes
Trav. Lead Tach	Yes	Yes
Trav. F.F. Gyro	Yes	Yes
Trav. 3rd Stage Xducer	Yes	Yes
Trav. Diff. Press. Xducer	Yes	Yes
Trav. Servo Valve	Yes	Yes
Mode Switches	Yes	Yes
Trav. Deck Interference SW.	Yes	Yes
El Deck Interference SW.	Yes	Yes
Mode Indicator Lamps	Yes	Yes
Stab. System Cable 1W200	Yes	No
Power Distribution		
To individual sensors	Yes	No
To all sensors collectively	Yes	Yes
Control System Overall Stability	No	Yes
Faulty Computer Stabilization Program	No	Yes

POTENTIAL M1E1 BLOCK II TURRET MULTIPLEXED SUBSYSTEM



SCHEDULE
MCDP CONCEPT 6
DIGITAL TURRET



M1E1 BLOCK II TURRET ENHANCEMENT COSTS

LRU	RDT&E COSTS	PRODUCTION COST/UNIT	M1 REPLACEMENT PRODUCTION COST FY85 DOLLARS
TURRET STABILIZATION TERMINAL	$795,000	$ 9,000	$ 4,909
COMMANDER'S DISPLAY AND CONTROL PANEL	$650,000	$10,500	$ 930
TURRET NETWORKS BOX (TNB) WITH SOLID STATE SWITCHED/RELAYS AND CONTROLS	$995,000	$16,000	$14,280

COST SUMMARY SHEET[1]

($FY85 CONSTANT)

CONCEPT 6 Digital Stabilization System, Fire Control Computer and Commanders Display and Control Panel Interconnected with Data Bus Structure.

DEVELOPMENT:

	Digital Stabilization System	795K
[illegible] month Effort	Commanders Display & Control Panel (CDCP)	650K
	Turret Networks Box (TNB) with Solid Switches Relays and Controls	995K
		2440K

UNIT HARDWARE COST[2]

	Proposed		Existing Hardware		Cost
Digital Stab System	10K	-	4.9K	=	5.1K/veh
CDCP	11K	-	1 K	=	10 K/veh
TNB with Solid State	16K	-	14 K	=	2. K/veh
TOTAL	37K		19.9K		17.1K/VEH

NOTES:

1 Unvalidated, Preliminary Engineering Estimate of Upper Level of Cost Source: AMSTA RGDD, Nov 84.

2 Based on Quantity of 1000 Units.

MCDP CONCEPT 7

INCORPORATION OF ELECTRONIC MANUAL
WITH ANY OF THE PREVIOUS CONCEPTS

(SOFTWARE/HARDWARE UPGRADE)

TECHNICAL DESCRIPTION

ELECTRONICS MANUAL IMPLEMENTED WITH ANY OF THE PREVIOUS CONCEPTS

It is the concensus opinion of the JWG that the electronic manual, while offering enhanced capabilities of MCDP, it not defined well enough presently, either techncially or philsophically, to be included in a short time frame MCDP development. Development or an Electronic Manuals is an extensive program in its own right and combining its effort with MCDP would detract from its development and could lead to an end item that presented no more for the soldier than an electronic page turner.

A report on electronic manual concept and hardware is included for information purposes at Addendum 7.

The technical risk for incorporation of an effective electronic manual within the MCDP program time frame is considered high. The concept, therefore, is considered invalid at this time.

MCDP CONCEPT 8

ACCELERATED VETRONICS

(TECHNOLOGY INSERTION)

ACCELERATED VETRONICS

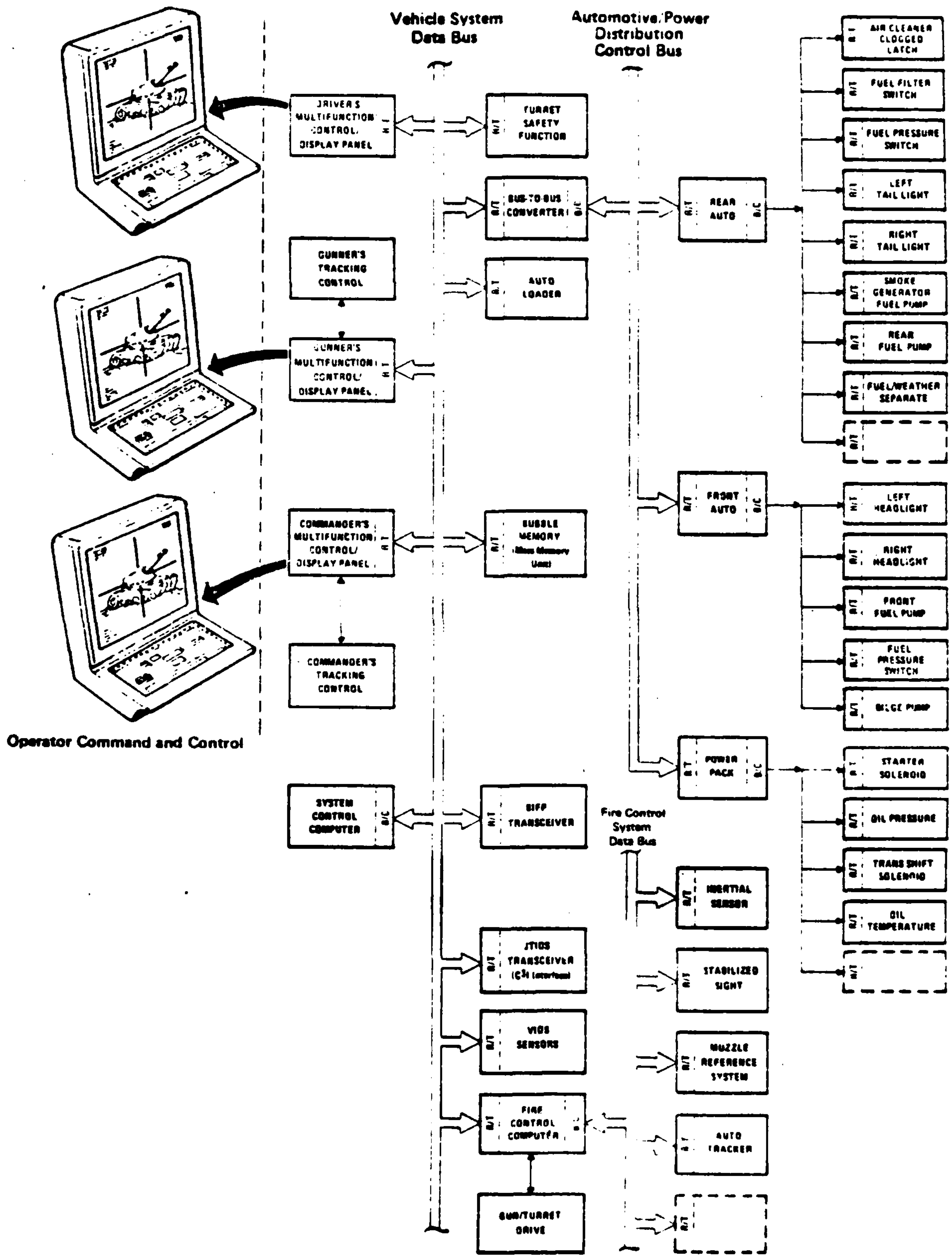
Vetronics (Vehicle Electronics) is defined as the discipline for total integration of vehicle electrical/electronic systems. The approach being taken is to develop and implement an electrical system architecture utilizing computer - controlled, bussed, multiplexed data and power distribution with multifunction controls and interactive displays.

The subsystems will interface to the vehicle as "Black Boxes" rather than stand alone systems found in todays vehicles which are in effect combined rather than truly integrated. All power distribution, data interchange between subsystems processor assets, and control/display interface with the crew will be controlled by the Vetronics structure. Definition and standardization of the architectures of the power distribution bus, data bus, processor assets and control/display functions are the focus of the Vetronics program.

Since the Vetronics vehicle would in effect contain all "smart" systems using micro-processors, it could monitor its own subsystems, communicate with the outside electronic battlefield and perform select automatic functions with minimal crew intervention (robotics). On 30 August 1984, four contracts were awarded to RCA Corp., Texas Instruments, FMC Corp., and General Dynamics Land Systems Division for individual 24 month development efforts to perform concept definition/technology demonstration (Phase I) for the Vetronics System Architecture. This effort will include systems engineering to develop draft specifications and standards that will define the data distribution system, the electrical power management system and interface requirements for subsystems. In the Advance Development Phase (Phase II), a single contractor will continue the development of the Vetronics System Architecture and fabricate a new demonstrator. This architecture will either be the "best" of the four developed in Phase I, or be an entirely new architecture containing the best characteristics from all four.

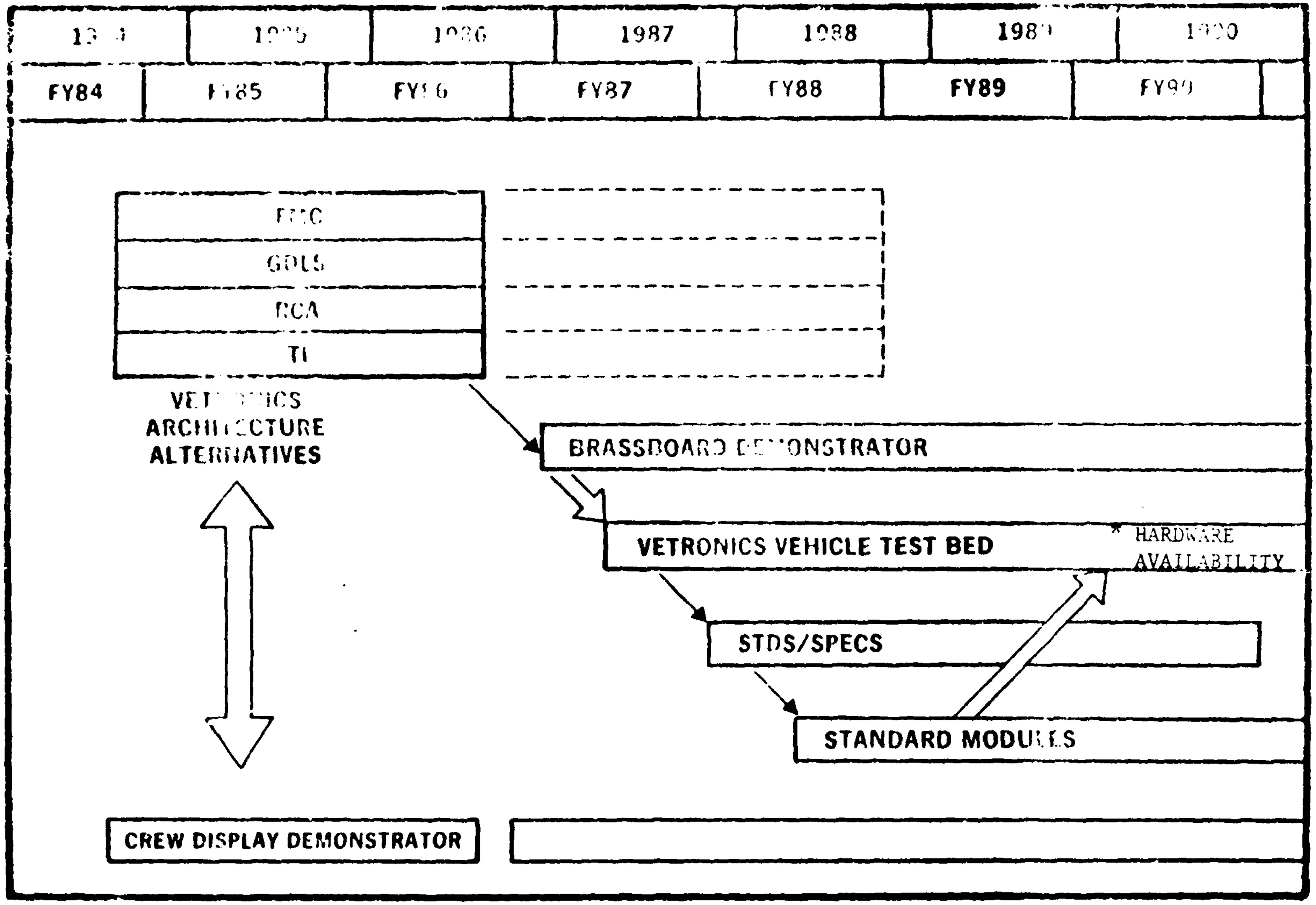
Acceleration of the program would require a decision on architecture prior to the scheduled "shoot-off" greatly increasing program technical risk as well as cost. The maximum shortening of the schedule is 16 months with a possible order of magnitude cost impact.

Program acceleration is therefore not recommended.



Vehicle System Data Bus
Automotive Power Distribution Control Bus
Fire Control System Data Bus
Operator Command and Control
DRIVER'S MULTIFUNCTION CONTROL/ DISPLAY PANEL
TURRET SAFETY FUNCTION
BUS-TO-BUS CONVERTER
REAR AUTO
AUTO LOADER
GUNNER'S TRACKING CONTROL
GUNNER'S MULTIFUNCTION CONTROL/ DISPLAY PANEL
COMMANDER'S MULTIFUNCTION CONTROL/ DISPLAY PANEL
BUBBLE MEMORY (Mass Memory Unit)
FRONT AUTO
COMMANDER'S TRACKING CONTROL
POWER PACK
SYSTEM CONTROL COMPUTER
SIFF TRANSCEIVER
INERTIAL SENSOR
JTIDS TRANSCEIVER (C³I interface)
STABILIZED SIGHT
VIDS SENSORS
MUZZLE REFERENCE SYSTEM
FIRE CONTROL COMPUTER
AUTO TRACKER
GUN/TURRET DRIVE
AIR CLEANER CLOGGED LATCH
FUEL FILTER SWITCH
FUEL PRESSURE SWITCH
LEFT TAIL LIGHT
RIGHT TAIL LIGHT
SMOKE GENERATOR FUEL PUMP
REAR FUEL PUMP
FUEL/WEATHER SEPARATE
LEFT HEADLIGHT
RIGHT HEADLIGHT
FRONT FUEL PUMP
FUEL PRESSURE SWITCH
BILGE PUMP
STARTER SOLENOID
OIL PRESSURE
TRANS SHIFT SOLENOID
OIL TEMPERATURE
R/T
B/C

VETRONICS MASTER PLAN



VETRONICS DEVELOPMENT COST IN $ X 1000

	FY84	FY85	FY86	FY87	FY88	FY89	FY90
6.2	1700	2000	2300	1800	1800	2000	2000
6.3a	350	3800	2381	3144	3601	3110	3610
TOTAL FUNDED	2050	5800	4681	4944	5401	5110	5610

MCDP CONCEPT 9

ACCELERATED VETRONICS WITH
AUTONOMOUS PARTS REQUISITION SYSTEM

(TECHNOLOGY INSERTION WITH EXTERNAL HARDWARE IMPACTS)

TECHNICAL DESCRIPTION

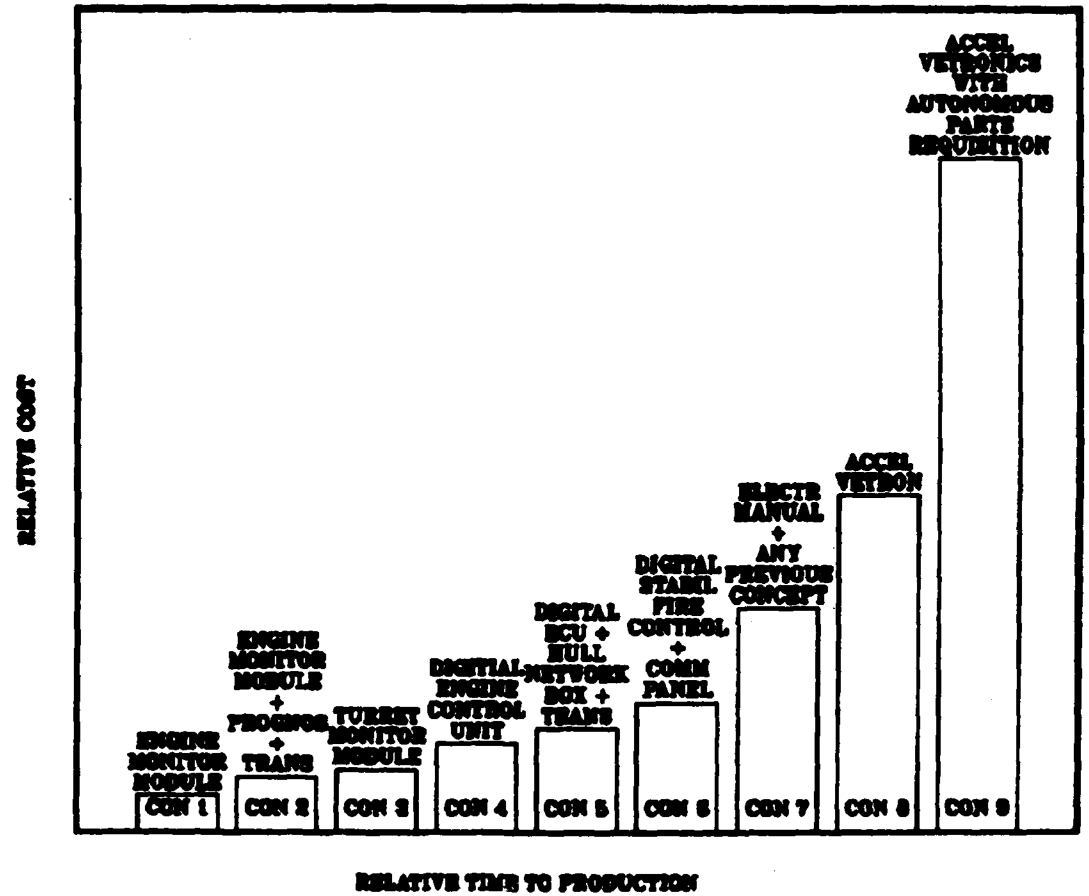
VETRONICS WITH AUTONOMOUS PARTS REQUISITION SYSTEM

This concept involves utilization of expanded Vetronics with an automated satelite communications system link to depot such that automatic sensing of parts need due to failure or projected failure would alert the system. Parts requisition would be automated through the pipeline and the required maintenance crew would be alerted for the return of the vehicle.

This concept was deemed to expensive and well beyond the MCDP time frame requirements to be given serious consideration by the JWG. No schedule or cost figures were developed.

SUMMARY OF CONCEPTS

CONCEPTS FOR A MAINTENANCE CONTROL & DISPLAY PANEL–MCDP



CONCEPT SUMMARY FOR A
MAINTENANCE CONTROL
AND DISPLAY PANEL (MCDP)

CONCEPT	CAPABILITIES	SOFTWARE/HARDWARE	BENEFITS	COST	SCHEDULE
1 EMM A Smart Data Logger with Interface Unit	Data Base Dev & On-Board Fault Diagnostics for Engine	Executive Control Software Data Logger Operator Interface Unit	On-Board eng system failure ID Level 1 Diagnostics Maintenance Assist	Dev $8M Unit $10K	24 Mo ED 30 Mo Hardware
2 EMM + Transmission Monitor & Prognostics	On-Board Fault Diagnostics for Engine and Transmission	Concept 1 + Sensors, Cables & small software for transmission Large software data base for Prognostics	Adds transmission and Prognostics with min additional hardware	Dev $6.6M Prog $3.5M Unit $16K	24 Mo ED 30 Mo Hdwr 3.5 yrs for Prog
3 TMM	Turret Data Base Dev & On-Board Diagnostics for Stab & Fire Control	50% more software than Concept 1 Hardware similar	Low cost add-on for turret Diagnostics	Dev $9M Unit $10K	30 Mo ED 36 Mo to Hardware
3A VMM	Implementation for both hull and turret with same hardware baseline	Hardware identical for hull and turret Unique software	Same support for both hull and turret Standardization	Dev $10M Unit $12.5K	36 Mo ED 42 Mo to Hardware
4 DECU	Technology insertion Data Base Development On-Board Fault Diagnostics for Engine	Digital fuel control Executive software Data Logger Bus interface	Upgrades ECU Building block for vetronics Detects "soft" engine failure	Dev $10M Unit $15K Replace $10K	30 Mo ED 39 Mo to Hardware

CONCEPT	CAPABILITIES	SOFTWARE/HARDWARE	BENEFITS	COST	SCHEDULF
5 DECU HNB + Transmission	On-Board Diagnostic for major hull systems	Concept 4 plus trans sensors and hull networks logic	Upgrades ECU and HNB Diagnostics for most hull systems	Dev $14.1M Unit $21K Replace $10K	39 Mo to Hardware
6 ATEPS Turret	Turret Data Base for On-Board Diagnostic for stab and fire control	Executive control software with digital stab and fire control Data bus logic	Upgrades stab, fire control and comm panl. Expand to BMS and Vetronics	Dev $2.4M Unit $37K Replace $19K	24 Mo to Hardware
7 Electronic Manual	TM 123P	Mass Memory (ROM) operator interface display/audio	On-Board repair direction Easy access Parts Ident Teaching Machine	HIGH	N/A
8 Accelerated Vetronics	System Integration Complete MCDP Concept	Developmental Software Development Hardware	BMS incorporation reduced hardware cost-effectiveness effective integration Full MCDP Benefits	HIGH	5 yrs min
9 Vetronics with Auto Parts Requisition	MCDP and supply pipe line management	Order/Supply Presidence Data Link to Depot	Refines ILS	VERY HIGH	N/A

Addendum 1

Tasking Message

ROUTINE * U N C L A S S I F I E D *
RT 00062 257/05457 PAGE 01

TANK AUTOMOTIVE COMMAND - USACC DETROIT

FOR COMMUNICATIONS ASSISTANCE CALL EXT 45143

/COMMUNICATIONS DISTRIBUTION DRSTA, PMS, OTHER ACTIVITIES/

A CA CC CD CE CG CH CI CO CP CW CT CY CXW CZ C F

F G H I L M NE P Q S V X XY CE EVS GCM IA 4113 MS

RG TV ASNC-TAC ICOMMCEN COE MCLAO UCSA-IAO GELAO 70TH

300TH 524TH CDLS/C/ MSX7-WAP

RTTUZYUW RUKLDAR4400 2570534--UUUU--RUCILWA.
ZNR UUUUU
R 121305Z SEP 84
FM CDRUSAMC ALEX VA //AMCDE-SG//
TO RUCILWA/CDRTACOM WARREN MI //AMCPM-GCM//
INFO RUCILWA/CDRTACOM WARREN MI //AMSTA-RGD/AMSTA-M/AMSTA-CG//
RUCIFAA/CDRUSAARMC FT KNOX KY //ATSB-MT//
RUCLATA/CDRTRADOC FT MONROE VA //ATCD-MM//
BT
UNCLAS
SUBJ: CONCEPTS FOR MAINTENANCE CONTROL AND DISPLAY PANEL (MCDP)
1. THE AMC COMMAND GROUP HAS EXPRESSED INTEREST IN CONCEPTS FOR AN AUTOMATED MCDP THAT WOULD IMPROVE MAINTAINABILITY THROUGH NON-VOLATILE STORAGE OF FAULTS THAT OCCUR DURING OPERATION AND PROVIDE A FUNCTIONAL TEST CAPABILITY FOR MAINTENANCE PERSONNEL. THESE PANELS WOULD BE SIMILAR TO THOSE USED BY BOEING ON THEIR 757 AND 767 AIRCRAFT. AVSCOM HAS BEEN ASKED TO EXPAND THEIR USE OF THIS CONCEPT AND STUDY POTENTIAL BENEFITS IN TERMS OF REDUCED MAINTENANCE COSTS AND MANPOWER.
2. THE CG DESIRES THAT THE FEASIBILITY OF PROVIDING THIS CAPABILITY FOR TRACKED VEHICLES BE INVESTIGATED. ALTHOUGH TACOM IS WORKING ON 6.2 AND 6.3A RDT PROGRAMS (VETRONICS AND ADVANCED

PAGE 02 RUKLDAR4400 UNCLAS
DIAGNOSTICS/PROGNOSTICS) THAT WILL PROVIDE THIS CAPABILITY FOR THE NEXT GENERATION OF COMBAT AND TACTICAL VEHICLES THE DCGRDA HAS INDICATED THAT AMC SHOULD NOT BE WILLING TO WAIT FOR VETRONICS AND THE NEXT GENERATION OF VEHICLES TO TAKE ADVANTAGE OF THE MCDP CONCEPT.
3. REQUEST YOU CONDUCT A FEASIBILITY EVALUATION OF ALTERNATE CONCEPTS THAT COULD PROVIDE A MCDP CAPABILITY FOR EXISTING TANKS THAT COULD BE PART OF A BLOCK MODIFICATION PROGRAM FOR THE M1 OR A RETROFIT PROGRAM FOR FIELDED TANKS.
4. THE EVALUATION SHOULD ADDRESS TECHNICAL FEASIBILITY, COSTS,

XO (E) standardize action ...

DIST	~~CG~~
Info	~~[illegible]~~
INFO	MANT
Action	RDD

ROUTINE * U N C L A S S I F I E D *

19 SEP

AND POTENTIAL BENEFITS (SUCH AS OMA AND MANPOWER SAVINGS, COST AVOIDANCES DUE TO EARLY DETECTION OF FAILURES ETC.) THE TRADOC COMMUNITY SHOULD BE INVITED TO PARTICIPATE IN THE EVALUATION TO DETERMINE THE USER POSITION ON THE MCDP CONCEPTS.

5. REQUEST YOU FURNISH THE FOLLOWING INFORMATION TO THIS OFFICE BY 10 SEPTEMBER:

A. NAME, OFFICE SYMBOL, AND PHONE EXTENSION OF POC FOR THIS EFFORT.

B. MILESTONE SCHEDULE TO ACCOMPLISH EVALUATION.

6. BACK-UP DOCUMENTATION WILL BE FORWARDED TO THE POC WHEN

PAGE 03 RUKLDARR8400 UNCLAS

IDENTIFIED.

7. HQ AMC POC IS MR. GENE DUNCAN, AMCDE-SG, AUTOVON 284-9872.

BT

#8400

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Addendum 2

MCDP Joint Working Group Participants

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Dan Ustick	TACOM, ATTN: AMSTA NKS, Warren, MI 48090	(313) 574 5061 AV 786 5061
Peter T. Walker	TACOM, ATTN: AMSTA RGDE, Warren, MI 48090	(313) 574 8530 AV 786 8530
Dave Weller	AVSCOM, ATTN: AMSAV NS, 4300 Goodfell w Blvd, St Louis, MO 63120	(313) 263 1074 AV 693 1074
J. W. Wollam	TACOM, ATTN: AMCPM GCM SI, Warren, MI 48090	(313) 574 8192 AV 786-8192
Marquis Woody	TACOM, ATTN: AMSTA RGDE, Warren, MI 48090	(313) 574-5696 AV 786-5696
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Addendum 3

MCDP Joint Working Group Minutes

Minutes for Maintenance Control and Display Panel (MCDP) Joint Working Group Session of 17-18 October 1984.

1. The session was opened at 1000 hrs by TACOM POC J. Steyaert who outlined the reasons for conveining the JWG. A copy of the AMC message concerning MCDP was issued as a handout. Objectives of the session were stated:

a. Document MCDP need
b. Determine level of technical achievability for various concepts
c. Develop program schedules
d. Project estimate of upper limit of probable cost

The output of the group would be a report containing an executive summary, a technical description of each concept, a line or block diagram of each concept, a program schedule, a rough cost outline and appropriate addendums.

2. Mr. J. Wollam from the M1 Program Office and Mr. P. Ericson from General Dynamics Land Systems combined to present the aspects of the M1 vehicle diagnostic and interface situation. System complexity, time to diagnose and turn in of components with no evidence of failure (NEOF) were the primary areas stressed. The presentation did not address a MCDP device directly but left little doubt that such a device would be beneficial in supporting the tank. Mr. J. Montgomery from Ft. Knox supported this position by pointing out that in the present scenario it is virtually impossible to meet the two hour requirement for diagnose and repair in the forward area which results in assets being evacuated rearward.

3. Mr. G. Howe from the M1E1 office briefed on the presently planned block improvement insertion schedule which could possibly be utilized for implementation of MCDP. Schedule is included as enclosure 1.

4. A Vetronics program overview was presented by Mr. P. Walker of the TACOM R&D Center. The presentation left the JWG with the feeling that the Vetronics concept is ideal for new development vehicles in the 1990's time frame, is a well conceived program that is scheduled fairly optimisticly and increased funding to accelerate the program would be able to shorten the program by only 16 to 18 months while forcing major revisions to the acquisition strategy and greatly increasing the technical risk. It was the concensus of the group that a full Vetronics implementation on the M1 would fulfill the MCDP requirement but it could not be fielded within the time frame of interest of the JWG.

5. The Boeing representative did not attend the session pleading a priority in working a General Thurmund initiative with PM CH47. In Boeing's absence Mr. D. Weller from AVSCOM presented the Aviation Community's system overview. The insight into the helicopter's unique problems as well as those that are common with the Tank-Automotive community reveals that the Boeing system (from 757/767 applications) is an "overkill" application for the MCDP. The system would be costly (estimated at $500,000 per tank) and there is no data base system available, or planned for the near future, to allow the full benefits of off-board data base establishment that is one of the key factors derived from the system.

6. Mr. L. Ferguson from General Dynamics Land Systems presented a concept of adding a "smart" data logging device to the tank with interface to the engine through the ECU diagnostic connector. The device would have a driver alert panel to give warnings of problems detected. The maintenance crew could then utilize the system to do level 1 diagnostics through some sort of operator interface unit. The concept has merit, is relatively inexpensive, lends itself well to expansion to the transmission and possibly the turret and has potential for prognostics.

7. Mr. R. Hanson from RCA gave a presentation on utilizing new technology for the hull systems to implant the MCDP capability. The concept centered on the addition of a digital ECU with a built in engine monitor to be used in the same manner as the previously mentioned "add-on" monitor. Advantages included enhance performance and reliability for the ECU, direct replacement and the inclusion of bus interfaces to make it usable with the future Vetronics System.

8. Mr. M. Woody from the TACOM R&D Center and Mr. P. Gulbis from Chrysler-Huntsville combined to give a presentation on new technology for the turret that fulfills the MCDP requirement. The presentation was more technically detailed than expected and presented many enhancements that should be given consideration for the M1 Block improvement programs. The system has built-in diagnostics and multiple displays that give a good MCDP capability.

9. At 1630 hrs the meeting adjourned and was rescheduled to reconvene at 0830 the following morning.

10. Mr. J. Steyaert reopened the meeting at 0835, presented a viewgraph outlining the possible MCDP options (Enclosure 2) and asked the group if there were any others available for consideration. No additions were suggested.

11. Mr. B. Liptak from the TACOM PIP office gave a presentation on PIP Process Requirements. It was the concensus of the group that if the MCDP concept were to be implemented in the time frame desired funding would have to be reprogrammed and some requirements waived.

12. Mr. G. Duncan from AMC gave a briefing on expediting the funding and schedule process. The priority given to MCDP apparently is the driving requirement for expeditious programming. He also noted that MCDP would fit well into the Log R&D area which could be a good funding source. He volunteered to check on potential funding sources. He also pointed out that AMC wants to shorten the cycle for major weapon system acquisition to 4 years and major PIPs to 2 years. The group rebutted this by pointing out that AMC has always been reluctant to accept the increased program cost and technical risk associated with this strategy. Congressional mandates for increased competition, the establishment of the AMC Office of Acquisition Management and DoD 4245.7-M were mentioned as obsticles to shortening the acquisition cycle.

Mr. Duncan pointed out that the changes may not occur overnight but the changes would assuredly be implemented. He also pointed out that the matrix of the concepts and advantages handed out would be good to have in the report with development and production cost information added.

13. Mr. J. Blum from the Ord Center and School gave a briefing on the User requirement for MCDP. He outlined some of the problems the user has with present test equipment such as: equipment is too bulky, not enough of it to support the Fix Forward concept, requires too much human input and there is too big a volume of TMs required. He also emphasized that BITE can only be as good as its inputs and its interface with the humans involved. BITE should use existing sensors where possible and the user needs to be able to operate the vehicle in case of sensor failure. To be really effective the MCDP must be user friendly, eliminate dependance on TMs and identify to the faulty subsystem with identification to faulty piece part whenever possible.

14. Other discussion dictated that the MCDP should be nuclear hardened to the same degree as the other systems on the tank. If for some reason that were not possible it would at least be required to produce no detrimental effects to the nuclear hardening capabilities already existing on the vehicle. The waiver for nuclear hardening of the MCDP would probably require 6 to 9 months of processing for approval following submission if required.

15. The group agreed that rough order of magnitude costs for development and production would be all that is required for this study. Detailed costs were discouraged because they could not be made available for all options. Cost benefits were discussed at length with no firm handle on how to project valid numbers for anything other than NEOF components. AMC offered to investigate a method of equating increased availability to dollars.

16. The following taskings to be completed by 2 November were assigned to JWG members:

AMC (G. Duncan) will investigate the availability of Log R&D Funding for MCDP.

APG (J. Blum) will prepare a training impact statement for the various MCDP concepts.

AVSCOM (D. Weller) will investigate the availability of an O&S cost model and supply handcopy of his viewgraph presentation.

CECOM (L. Zanelli) will provide details on the level at which Ada would become a requirement for a MCDP concept.

Ft. Knox (J. Montgomery) will provide the priority placement of diagnostics in the FAA, develop a draft need assessment for developing MCDP and check with MRSA for information on repair parts costs and numbers applicable to NEOF reductions.

General Dynamics (L. Ferguson) will provide a technical description and concept line drawing of the enigne monitor module concept for MCDP.

RCA (R. Hanson) will provide a technical description and block diagram of the "smart" digital ECU concept for MCDP.

Chrysler Huntsville (P. Gulbis) will provide a technical description and block diagram of the "smart" digital stabilization system with data bus concept for MCDP turret application.

General Dynamics (L. Ferguson) will provide a technical description and line drawing or block diagram for two concepts of MCDP turret application. One will be a separate "add on" for the turret while the second concept will utilize the same box in the turret that would be used in the hull.

General Dynamics (P. Gutzman) will provide a concept for the addition of an electronic manual capability that would provide more than just an "electronic page turner".

TACOM (M. Woody) will provide a technical description, block diagram and schedule for the Vetronics program.

TACOM (J. Wollam) will provide technical details, schedule and estimated costs for the "Expanded BITE for the Turret" program.

AMC (C. Adenauer) will provide a method of equating increased availability to cost benefits.

TACOM (J. Steyaert) will provide a copy of JWG session minutes for comments/approval.

17. A list of attendees for the joint working group session is attached as enclosure 3.

18. Joint working group session was adjourned at 1400 hrs.

Respectfully submitted,

Joseph W. Steyaert

JOSEPH W. STEYAERT
Chairman, MCDP JWG

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Addendum 4

PM CH47 Memorandum Report

DRCPM-CH47M-T/-L 24 Jul 84

MEMORANDUM FOR DEPUTY COMMANDING GENERAL FOR RESEARCH AND DEVELOPMENT

SUBJECT: Boeing Models 757/767 Maintenance Control and Display Panel (MCDP)

1. AVSCOM was tasked on 20 Jul 84 to determine the maintenance system, as used by Boeing on the 757/767 aircraft, and its potential application to Army helicopters, i.e., CH-47D, UH-60, AH-64, and LHX.

2. Boeing installs the MCDP in its newest aircraft to provide the airline line maintenance technician with a number of troubleshooting aids. The MCDP is an interactive digital computer that improves maintainability through its nonvolatile storage of in-flight faults and its functional test capability on the ground.

3. The fault retention memory of the MCDP relies on the monitoring capability provided by three Flight Control Computers (FCCs), one Thrust Management Computer (TMC), and two Flight Management Computers (FMCs). Each of these computers monitors its internal operation, as well as failure of input data attributable to specific external Line Replaceable Units (LRUs) or a group of LRUs. These computers record flight fault data that cause a discrete flight deck indication reported by the crew. At touchdown, the MCDP is switched on by the air/ground logic, and the faults are transferred from the six computers into the nonvolatile storage of the MCDP. This data is then available to the ground crew for correction of a recommended fault either by adjustment or replacement of the LRU. The data is also fed to a central data base for long-term trend analysis.

4. While the specific architecture of the MCDP is controlled by a commercial specfication not compatible with DOD MIL-STD-1553B, the technology utilized by MCDP in diagnosing and locating faults is presently in the AH-64A and the AHIP and is intended for the LHX. The use of this same technology with the correct architecture would require a complete redesign of the CH-47D and the UH-60A helicopters as the add on/strap-on approach has not been successful. The complete redesign of the CH-47D and UH-60A helicopters is considered prohibitive from both cost and time.

5. Though AVSCOM is using, and will continue to use MCDP technology via different architectural levels of MIL-STD-1553 full effectiveness is constrained by the lack of a large fixed base central processing facility. TWA has data retrieval stations in Los Angeles, Kansas City and New York. All the retrieved data goes to Kansas City where the main line computer is located and utilized by a staff of people who analyze the data for scheduled maintenance, component replacement, and trend analysis. The basic AH-64A data is used at the aircraft but is not stored. The AHIP data is used and stored at the aircraft but has no central processing facility or trained personnel to perform any analysis. A study is needed to determine the requirements for the storage, retrieval, and processing of the maintenance significant fault data which is, or could be, made available.

6. This technology should reduce both the number and skill level required at the unit level (LRU replacement) and should reduce the number of spares required in the logistics pipeline (more accurate troubleshooting). This savings will, however, be partially offset by an increase in technical skills required at the AVIM/depot level to support the repair/return of LRUs.

7. In summary, the Army is using or intends to use, the Boeing MCDP technology (with different architecture) in the AH-64A, the AHIP, and the LHX. Retrofit of this technology in the CH-47D and the UH-60A is considered prohibitive from cost and time considerations as the entire electrical/electronics equipment must be converted. A study is needed to determine the needs for a central data processing facility and staff for full use of the accumulated fault data.

SIGNED

N. I. PATLA
COLONEL, AV
Project Manager for
CH-47 Modernization

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Addendum 5

MCDP Training Impact Assessment

UNCLAS

01 02 011301Z NOV 84 PP PP UUUU AT ZYUW 30314302

FM CDR ORDCENSCH APG MD //ATSL-CD-MS//

TO CDR USATACOM WARREN MI //AMSTA-RGDD//

INFO CDR TRADOC FT MONROE VA //ATCD-MH//

CDR LOGC FT LEE VA //ATCL-M//

COMDT USAARMS FT KNOX KY //ATSB-CD-ML//

UNCLAS

SUBJECT: CONCEPTS FOR MAINTENANCE CONTROL AND DISPLAY PANEL (MCDP)

A. MSG, HQ USAMC, AMCDE-SG, 121305Z SEP 84, SAB

B. MCDP JOINT WORKING GROUP, USATACOM, 17-18 OCT 84

1. USAOC&S WAS REQUESTED TO PROVIDE USATACOM AN ASSESSMENT OF TRAINING IMPACT FOR EACH OF THE MCDP ALTERNATIVES AS AN ACTION ITEM OF THE JWG REFERENCE B.

2. DUE TO THE COMPLEXITY OF THE ISSUES AND TIME REQUIRED FOR STAFFING, IT WILL NOT BE POSSIBLE TO COMPLETE THIS ACTION WITHIN THE DESIRED TIME FRAME.

3. FOLLOWING IS AN INTERIM ASSESSMENT OF TRAINING ISSUES. A MORE DETAILED STUDY WILL BE UNDERTAKEN UPON COMPLETION OF ASSESSMENT OF NEED BEING FORMULATED BY USAARMS.

4. TRAINING FOR TANK CREWS WILL REQUIRE INSTRUCTION ON MCDP FUNCTIONS AND ACTIONS TO BE TAKEN BASED ON OBSERVATION OF MONITORING

DISTR

JULIUS F. BLUM, GS-12, LOG SPEC
ATSL-CD-MS, AV 283-5329

ERNEST A. BECKING, COL, OD, DCD
ATSL-CD, AV 283-5698
ORIGINAL SIGNED 1306 0900Z OCT 84 UNCLAS

JOINT MESSAGEFORM UNCLAS

02 02 OCT 84 PP PP UUUU AT ZYUW 303143OZ

WARNING LIGHTS OR DISPLAY PANEL. EXTENT OF ADDITIONAL TRAINING WILL DEPEND ON CREW ACTIONS REQUIRED. TRAINING IMPACT WILL BE MINIMAL FOR THE FOUR ALTERNATIVE MCDP CONCEPTS UNDER CONSIDERATION.

5. AT UNIT LEVEL, ADDITIONAL TRAINING WILL BE REQUIRED AS FOLLOWS:

A. REQUIREMENTS LISTED IN PARAGRAPH 4 ABOVE.

B. TROUBLESHOOTING LOGIC REQUIRED BY MCDP.

C. ACTIONS TO BE TAKEN IN CASE OF MCDP FAILURE.

D. APPLICATION OF EXISTING TMDE TO MCDP.

6. PROGRAMS OF INSTRUCTION FOR INTERMEDIATE LEVEL MOS WILL REQUIRE TRAINING ON MAINTENANCE OF MCDP COMPONENTS IN ADDITION TO THE REQUIREMENTS OF PARAGRAPHS 4 AND 5 ABOVE.

7. MCDP APPLICATION TO HULL COMPONENTS WILL AFFECT TRAINING FOR MOS 63E, 63H AND 63G. EXPANSION TO TURRET WILL AFFECT MOS 45E, 45K AND 45G. GS REPAIR OF MCDP COMPONENTS REQUIRING PRECISION SOLDERING OR CALIBRATION WILL AFFECT MOS 35H.

8. ABOVE LISTED REQUIREMENTS FOR MOS SERIES 45 AND 63 MAY BE OFF SET BY REDUCTION OF TROUBLESHOOTING TASKS, PROVIDING THAT MCDP DEVELOPMENT IS PARALLELED BY EFFORTS TO SCALE DOWN REQUIREMENTS FOR OFF LINE TMDE.

9. POC FOR THIS ACTION IS MR. JULIUS BLUM, AV 283-5329.

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Addendum 6

Assessment of Need Statement

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY ARMOR SCHOOL
FORT KNOX, KENTUCKY 40121-5215

ATSB-CD-ML

28 DEC 1984

SUBJECT: Assessment of Need Statement

Commander, US Army Ordnance Center & School, ATTN: ATSL-CD-MS, Aberdeen Proving Ground, Maryland 21005
Commander, US Army Training & Doctrine Command, ATTN: ATCD-MH, Fort Monroe, Virginia 23651
Commander, US Army Logistics Center, ATTN: ATCL-MC, Fort Lee, Virginia 23801
Commander, Tank Automotive Command, ATTN: AMSTA-RGDD, Warren, Michigan 48090

1. Attached is the revised user Need Statement for enhanced diagnostics of the M1 Abrams. Reviewer comments have been incorporated.

2. The user Need Statement is intended to identify user requirements to assist the Tank Automotive Command, Research and Development Laboratory in the evaluation of the Maintenance Control and Display Panel Study.

3. USAARMS point of contact for this action is Mr. James C. Montgomery, AV 464-1750/1250.

FOR THE COMMANDANT:

B. A. CHUMLEY
AG Admin Asst

1 Encl
as

CF:
PM-Tank, ATTN: DRCPM-GCM

US ARMY ARMOR SCHOOL
DIRECTORATE OF COMBAT DEVELOPMENTS
ASSESSMENT OF NEED STATEMENT
Fort Knox, Kentucky 40121-5215

1. PURPOSE: Documentation for assessment of need is provided as guidance to AMC for evaluation of Maintenance Control and Display Panels technology to enhance and improve the M1 Abrams diagnostics profile.

2. BACKGROUND:

a. Observations by field commanders, coupled with results from DT/OT testing, have prompted issuance of an Assessment of Need document. Unit mechanics performing diagnosis in a high intensity environment experience extreme difficulty in coping with the current cumbersome troubleshooting methodology. As observed by commanders during National Training Center (NTC) exercises, when the soldier becomes fatigues, his ability to use existing intrusive TMDE diminishes. Resulting reluctance of the soldier mechanics to utilize a recognized troubleshooting procedural approach in a realistically simulated NTC combat environment, typically results in trouble shooting by the swing test method. The TMDE fault isolation of system failures is frequently viewed as the most difficult technique to use. As the swing test method of troubleshooting is accepted as the quickest route to fixing the failure, No Evidence of Failure (NEOF) rates escalate. Currently the M1 Abrams is experiencing an approximate NEOF of 40%-60% on the items returned to DS.

b. Additional analysis of DT/OT data supports field observations. Although early software problems compounded the difficulty for use of unit TMDE during developmental and operational testing (DT and OT), mechanics' comments on the bulk, cumbersomeness, difficulty of use and transporting of automatic test equipment reflect current day problems.

3. REFERENCE: Several diagnostic investigations have been prompted by NTC reports, Commander's comments, and survey of mechanic personnel. The following investigative efforts are complete or in progress:

a. ARI - complete.

b. TRADOC JWG - in process.

c. TACOM TMDE - in process.

d. TACOM R&D Labs in process.

4. DEFICIENCY: Existing unit test equipment is bulky, cumbersome and difficult to use. As a result of systemic TMDE characteristics, the two hour support forward doctrinal concept cannot be met. Work around troubleshooting techniques has created unacceptably high NEOF rates and a resulting supply sided maintenance concept which is not supportable in high intensive operations. Current methods for interrogation of failed systems is time consuming and seldom systematically performed.

5. REQUIREMENT: It is required that M1 on-board state-of-the-art diagnostics be added to the system to enhance troubleshooting procedures and reduce intrusive TMDE hardware. On-board diagnostics must·

a. Provide capability to perform nonintrusive diagnostics to an 86 percent probability level of detection with an imbiguity group of no more than two system items and;

(1) As a minimum, effect the mobility system and provide for continued expansion into turret drive and fire control systems.

(2) Achieve nonintrusive diagnostics in a manner that all effected systems are compatible with VHSIC. All add on components must be self interrogating and must not degrade functional systems as a result of add on component failures.

(3) Have a diagnostic scale of data sampling which reflects whole system condition for anlaysis of multiple and intermittent faults.

(4) Provide an on board display of ambiguity group diagnostics results in clear text or graphic read outs without necessity for additional reference material or test equipment.

b. Integrate diagnostics in conjunction with evaluation for scale-down of

existing unit TMDE. (Each nonintrusive test should result in equivalent reduction of test set requirements.)

c. Identify critical faults (those which would result in complete system failure) and isolate critical faults to the PCB or module level for observation and possible correction by the crew.

d. Integrate to complement a prognostics program. (Prognostics capability should evolve to a 90 percent probability level of predicting success rates of mission completion.)

6. It is desired:

a. That the M1 on-board diagnoses system identify the fightability level of degraded systems and possible alternatives for continued combat operations.

b. That all technical manuals be evaluated for possible changes as a result of on-board diagnostic expansion. It is desired that technical manuals provide detailed guidance to further isolate ambiguity groups, using man portable TMDE, or alternate TS procedures to a single item solution.

c. BITE be expanded to eventually encompass 100% of the dianotic functions presently requiring the utilization of STE M1/FVS.

7. CONCLUSION: Vast improvement is needed within the area of M1 Abrams Combat

AD-A150 729 MAINTENANCE CONTROL AND DISPLAY PANEL (MCDP) CONCEPT FORMULATION(U) ARMY TANK-AUTOMOTIVE COMMAND WARREN MI J W STEYAERT DEC 84 TACOM-13058

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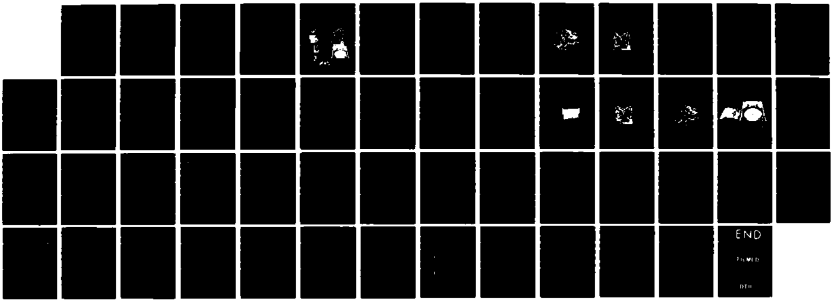

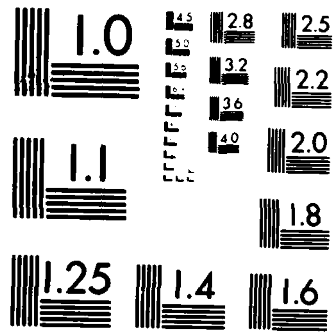
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Systems Support, at the unit level, to allow application of doctrinal concepts in the field.

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ADDENDUM 7

ELECTRONIC MANUAL CONCEPT REPORT

Automated Maintenance Information Systems

EXECUTIVE SUMMARY - COMPUTERIZED DOCUMENTATION AND TRAINING SYSTEM

1.0 Scope and Objective

This study is to determine the technical feasibility, types of hardware required and availability, and ROM costs associated with computerizing the operators and organizational maintenance Technical Manuals (TM) and Training material into an on-vehicle system.

2.0 Results of Investigation

The system was broken into 5 modules (see block diagram):

A. Display Unit
B. Data Storage
C. Input-Output (I/O) Device
D. Microprocessor and Control Circuitry
E. Rechargeable Battery Pack

2.1 Module E was included to provide system operating capability with a dead vehicle electrical system. Off-the-shelf units will be adequate.

2.2 The variety of microprocessors, solid state memory, etc... available today are flexible enough to meet system requirements. Therefore, module D is a design task.

2.3 Of the variety of display units, two have good potential for use. One consists of a small, helmet mounted CRT with the display projected in front of the users eye. This has the advantage that the display is always visible, but will require a transmitter/receiver combination to avoid awkward cabling. Large flat-panel displays could be used as an alternative, but introduce their own mounting and viewing problems.

2.4 The estimated data storage requirement for the TM/Training data is 500 megabytes. The only technology meeting this requirement is optical data storage. Optical disks have the advantage of gigabyte capacity (permitting free space for updates on the disk) but there are no ruggedized units available today. A second optical storage technique uses credit-

card size cards which store 4 megabytes on optical strips. The card readers are simple, rugged devices, but the maintenance/operator tasks would have to be structured to fit in the storage space available on the card.

2.5 The preferred I/O (man-machine interface) would be voice synthesis coupled with speech recognition. This permits the user to concentrate and use both hands on the task. This approach, when coupled with a helmet mounted display unit, provides a fully integrated I/O system. A back-up keypad I/O unit should be made available.

3.0 Cost

3.1 System hardware for incorporation into the vehicle is estimated in the $10-15,000 range per unit assuming video disk storage media. Optical cards would reduce these costs by about $4000 per unit.

3.2 Development of the software and restructuring of the TM/Training material is estimated at $1.6 million. Note that current method TM/Training development for this same material is $2.2 million.

4.0 Summary

It is technically feasible to integrate the TM/Training materials into a computerized on-vehicle system.

Further efforts are required to quantify the savings in life cycle costs to the Government.

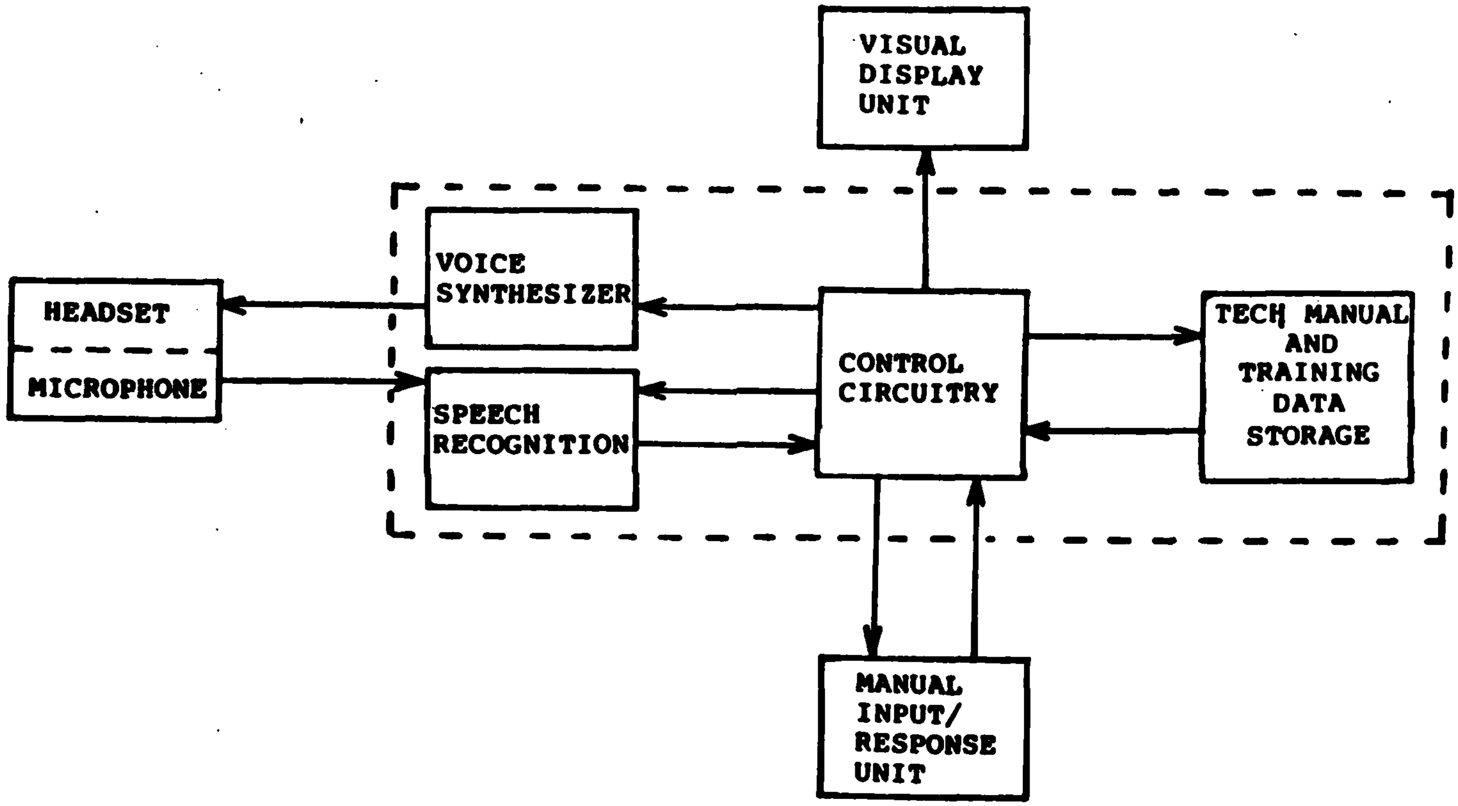
5.0 Recommendations

5.1 Initiate a follow-on effort to breadboard a system and test such alternatives as flat panel versus helmet mounted display units.

5.2 Establish contact with other companies working on similar systems, such as Honeywell Systems & Research Center, G. D. Electronics Div., etc... to investigate joint venture possibilities.

5.3 Approach TACOM and the Army community to obtain CRAD funding for these efforts.

COMPUTERIZED INTERACTIVE TECH DOCUMENTATION & TRAINING SYSTEM



BLOCK DIAGRAM

FINAL REPORT - COMPUTERIZED INTERACTIVE DOCUMENTATION AND TRAINING SYSTEM

1.0 PROBLEM

Inefficient and inaccurate maintenance and operation of equipment currently exists because of a number of conditions related to the maintenance, equipment, technical documentation, training, or environment. Consequently, maintenance or operation of equipment is not performed efficiently.

- o Equipment is not repaired.
- o Functional components are erroneously replaced.
- o Not-repairable-this-station (NRTS) judgements are incorrectly made.
- o Mean time to operate or repair is unnecessarily high.
- o Equipment is broken during operation or maintenance.
- o Equipment or maintenance equipment is underutilized.

Conditions leading to the inefficient operation and maintenance of equipment are:

- o Widening gap between skill level of users and the technological sophistication of equipment.
- o Technical manuals are difficult to use effectively.
  - oo Many manuals are required
  - oo Extensive cross referencing between and within manuals
  - oo Rely on verbal presentation, reading skills, and an ability to use the manual
  - oo Low fidelity line drawings
  - oo Manuals usually contain only one configuration of equipment, resulting in support problems for equipment of another configuration.
- o Intractable physical environment
  - oo Manuals are paperbound, highly susceptable to weather and operating conditions.
  - oo Manuals require stable, well lit, roomy space
  - oo Confined area within vehicle
  - oo Danger due to improper or inadvertent operation
  - oo Battle conditions, heat, noise, low light, wind, and other environment conditions
  - oo Equipment is observed by other equipment
  - oo Two hand maintenance needed

- oo User is physically removed from complete documentation sets.

- o Hostile equipment
  - oo Demands one correct procedure
  - oo Offers little identification of user errors
  - oo Supplies no corrective measures
  - oo Presents hostile environment to operator who is under stress.
- o All conditions interact. Maintenance and operation require simultaneous manipulation of test equipment, tools, documentation, and the equipment itself.

2.0 OBJECTIVE

The goal is to develop a system that will increase the correct operation or maintenance of equipment by eliminating the conditions that lead to inefficient operation and maintenance. It will:

- o Organize technical manuals and training methods so that they are compact, accessible, intelligible, always current, easily adaptable, and highly portable.
- o Will handle all forms of documentation, including technical manuals, training, and other logistics information.
- o Involve production, distribution, and delivery of doctrinal, instructional, and technical manuals.
- o Lessen the impact of physical environment on maintenance and operation of equipment.
- o Decrease hostility of equipment.

The long term objectives are to develop an automated technical documentation/training system. This system would replace classroom training and eliminate the requirements for printed documentation. The system would interface with an automated documentation system and an integrated logistics system. The system is intended to be implemented on board a combat vehicle/weapon system, for use in the operational environment of the combat vehicle for the life of that vehicle. It will consist of a mass data storage device, a display unit and devices to allow the user to interactively retrieve/display data (see block diagram, figure 1). The system is to first be implemented on the M1 Abrams Tank, but such a system has applicability for all combat vehicle/weapon systems, as well as other ground systems.

The short term objectives are to define the system requirements and determine feasibility of an automated technical documentation/training system. Once feasibility is demonstrated, the M1 Abrams Tank will be used as the prime system for prototype development. The study will include all elements of system capabilities, i.e. troubleshooting and maintenance procedures, computer aided instruction, etc.

2.1 Hardware Possibilities Pros/Cons

Conventional CRT technology will not be adequate for this system. CRT displays are too bulky and heavy, making them too difficult to use in a portable fashion in a confined area. Also, the electron tube is fragile, and the electronics can pose shock hazards. Fortunately, new technologies offer an alternative, with considerable savings in size, weight, and power.

Two options exist for the system display. One option is a large flat panel display, about 8½ X 11 inches in size. The new flat panel technologies presently offer thin, lightweight displays with good graphics resolution (see figure 2). However, because of the size of the screen, mountability may be a problem on rounded surfaces of confined areas. The displays tend to be expensive. Also, having to look aside at a screen is a distraction because of the interruption. And if the screen and an object are at different distances, the need for the eye to readjust its focus can be very tiring.

An alternative to the flat panel display is a small, helmet-mounted display. A small, one inch CRT is mounted in the helmet, and the image is projected over one eye by the use of fiber optics or mirrors. Added optics could make the image appear to be the same distance as the object, in order to reduce eye strain. With the display over one eye, the distraction of having to look away from the object in order to view the screen is minimized. The miniature CRT is very small and as a helmet-mounted system, very portable (see figure 3).

For a non-verbal input, a mouse or a display touch panel would not be adequate. They are easy to use, but the input possibilities must share the display. If the display was to fail, the user would not be able to control the system in order to utilize the audio output part. Also, the touch screen cannot be used with the helmet-mounted CRT option.

Speech synthesis of stored data frees the eyes for other tasks rather than having to read the data on the screen. Current technology is producing synthesized speech virtually indistinguishable from human speech. However, practical applications of speech synthesis have limitations

and trade-offs. In one method offering excellent quality synthesis-digitization and storage of complete words - memory capacity limits vocabulary size. A different method consists of storing basic elements of words called phonemics or allophones and then building words from these elements. In this case, memory capacity is no limitation, but the algorithm used in stringing the elements together offer an inferior synthesis. Most text-to-speech machines use this method. For the proposed system high quality synthesis is not necessary and the limited vocabulary that will be used will allow greater accuracy in the pronunciation of words.

Voice input, or voice recognition, is inherently more difficult than speech synthesis because of the variability of human speech. But audio input saves inputting time over conventional keyboards and frees the hands for other tasks. Ultimately, a speaker-independent, continuous speech recognition system will exist, but presently has not been achieved, except with elaborate, expensive, highly experimental equipment. Currently, speaker independence has been achieved for a limited vocabulary of isolated words. Greater memory, however, is needed for independence and independence increases the identification error rate. Memory size and error rates become prohibitive when large vocabularies are used. Most of the present systems are speaker-dependent, requiring the computer to first be "trained" with the voice it is to recognize. They also require that the words be spoken in an isolated manner. The number of words that can be recognized is also limited by time required for training and memory. The documentation and training system however, will need only a small vocabulary for user-system interaction, such as words needed for commands and menu selections. Present voice recognition systems also need a high quality input, such as microphones, but this will not be a problem since the system could interface through existing headsets and microphones.

Conventional solid state memory devices will be adequate for the system's firmware and other necessary internal storage. However, external mass storage must be used to store the vast amount of text and art. The mass storage medium must have a long lifetime, be insensitive to magnetic fields, dust, temperature, humidity, and vibration. Magnetic media is not viable for it is too susceptible to the environment. Bubble memory may eventually offer a solid-state alternative, as it is small and totally non-volatile, but it as yet has very limited mass storage capabilities. Optical media seems so far the only practical choice.

Optical media have several advantages over other storage media, including greater volume, faster retrieval, non-contact read/write heads, and low cost. Present media is non-erasable, but that is not necessarily a disadvantage, since it can still be updated by leaving blank space on the disk for future changes.

An optical disk and drive would allow all information to be stored on one disk and it can then be completely sealed against moisture (see figure 4). However, the drive may be susceptible to vibration and ruggedization of the system may not be possible. Present systems offer no way of quickly adding new information, since low cost systems are read-only.

An alternative to optical disks and drives is an optical card and reader system. It consists of optical cards the size of a standard credit card and each card can hold 4 MBytes of information. This system has no spinning parts and is smaller than disk systems, so it should be less susceptible to vibration. Data will need to be divided among the cards, but the cards are portable, easy to handle, and cheap. Updates will be easier - not every card will need to be updated and cards are easily accessible. A chance of loss or damage exists, but the cards are small and easily replaced at low cost. This system will allow every operator to have their own card, if it is necessary to store their own unique voice characteristics, (if present speaker-dependent voice recognition systems are used).

3.0 SYSTEM DESIGN CONSIDERATION

- One unit per vehicle.
- Unit is modular with 5 modules consisting of 1) display, 2) storage unit, 3) keyboard, 4) microcomputer with voice I/O, and 5) rechargeable battery pack.
- All modules will have a cross section no greater than 15 X 21 inches.
- Each module will weigh less than 70 lbs.
- All modules will be fully militarized.
- The system will be powered by 24V Vehicle Electrical System.
- The system will have 4 hour stand alone operational capability from the separate rechargeable battery pack module.
- The display shall consist of a helmet-mounted miniature CRT.
- Optic lenses may be used to allow variability in apparent distance from display screen to user's eye.
- If helmet-mounted CRT later proves infeasible, flat panel displays may be used.
- Display may be monochrome, must have graphics capability.
- Display should have resolution no less than 256,000 pixels.
- Flat panel display should have nominal 8 X 10" size for legibility.
- Flat panel display must be capable of being mounted almost anywhere within and external to the vehicle.

- To avoid a slip-ring interface between hull and turret, display will be interfaced to system by means of a low power TV transceiver, for use only inside tank to minimize RF signature.
- For use outside tank, display will be interfaced to system by means of cable and external connectors.
- Voice recognition and speech synthesis products currently on the market will be adequate. Some minor customization may be necessary.
- Speech synthesis and voice recognition will interface with standard tank intercom system to permit use of existing headsets and microphones.
- System will have small keyboard for alternative input to voice recognition. Keys will be specialized with available commands and selections.
- Mass storage device shall consist of optical cards and laser based card reader.
- Optical disk and drive could be used instead of cards and reader only if 1) drive can be ruggedized, and 2) disk and drive have read/write capability.
- All system control software must reside in system at all times.
- System should have self-tests that will identify unit malfunctions or improper use.
- Shall be menu driven, task oriented presentation.
- Allow text to be displayed on screen or verbally presented, but not both at the same time to avoid distraction.
- ADA should be used for any high level language requirements
- If speaker-dependent voice recognition is used, system must be able to recognize several voices.
- System will use a standard, not custom, microprocessor.
- Because of quickly changing technology, system must be easy to upgrade.
- Data shall consist of text and line art.
- Use artificial intelligence. This system cannot be just an "electronic page turner".

3.1 Differences from Original System Requirements

- Initially at least, display shall be helmet-mounted CRT instead of flat panel.
- Initially at least, mass storage shall consist of cards and reader, until disk and drive can be militarized and have write capability.
- Until, if ever, drives can be used, information should comprise only of training, operation, unique characteristics of the vehicle and maintenance that can be performed just by the vehicle crew and on-vehicle organizational maintenance tasks. In the instance, where the vehicle will need repair facilities, the facility can have a system with further repair or maintenance information.

4.0 COSTS

- o Expand business potential by:
  1. Enhancing product lines by increasing maintainability and combat readiness of the vehicle and crew.
  2. Increased market penetration by having a system that can be applied to other military vehicles.
- o System hardware - $10,000 to $15,000 per unit.
- o Components supplied by subcontractors, assembled by GDLS.
- o Software and data would be developed by GDLS.
  1. Software must be written.
  2. Text and art boards must be digitized.
  3. Text and art boards must be reorganized for automated system.

  This would be a one-time only cost.

  Estimates of software development, test and implementation are 30-40 man-years based on paper documentation. Current ILS projects in automation over the next two years could reduce this figure by 50%.
- o Current GDLS' cost average is $100 per page of TM or Training Lesson. Automation, such as CAD/CAM and word processing, lessens cost of generating and revising drawings and text.
- o New vehicles can draw on existing data base for their own systems.

4.1 Cost Analysis

Using the M1 vehicle as a basis, there are 1142 pages of operators manual and 12,974 pages of organizational maintenance manuals, giving a total of over 14,100 pages. In addition, there were approximately 8000 pages of Training material developed. At $100 per page, these 22,100 pages cost 2.2 million to develop.

Development of the new system, including data, is estimated at 1.6 million in manpower costs alone. Hardware development and implementation costs will push the total close to the cost of conventionally prepared documentation.

Therefore, in terms of development costs, the proposed system will show little or no savings, especially when the implementation costs of $10-15,000 per vehicle are considered. The savings will be realized in reducing the personnel training requirements and improving the efficiency of

returning the vehicle to service by maintenance personnel. Since these are Government incurred costs, this estimation is outside ~~to~~ scope of this study project, but they should be evaluated in the next phase and assessed against vehicle life-cycle costs to determine the benefits to the Government.

5.0 IMPACT

- o Reduce costs of documentation, training, maintenance, repair.
- o Increase contracts by having enhanced product lines.
- o Manuals must be reorganized and computerized.
- o Printing hard copy will be lessened, but computerized manuals will need to be reproduced.
- o Information can be revised and distributed faster.
- o M1 tank will need some modifications.
- o Less time needed for training, operations, maintenance, repair.
- o System will require Logistics support.
- o Since each vehicle will have its own system, system documentation can be uniquely configured for that vehicle (list of parts, improvements, etc.)

6.0 HARDWARE RECOMMENDATIONS

The following companies offer viable systems that can be used for the computerized documentation and training system.

6.1 DISPLAYS

Helmet-mounted miniature CRT display:

Honeywell's VIMAD (VOICE INTERACTIVE MAINTENANCE AIDING DEVICE) system. This system comes with a TV transceiver option, which would eliminate the problem of wiring the user to the system. Honeywell also has done extensive work with voice recognition, speech synthesis, and optical disk storage and has written software for development and operation of this system.

Flat panel displays are an alternative to the helmet-mounted CRT. They are expensive, averaging $3,000 to $4,000 each, and also tend to be heavy.

AC plasma technology appears to be the most advanced of the large screen flat panel technologies. It offers pixel memory, and so the screen does not need refresh circuitry. Two companies offer fully militarized, full size AC plasma screens:

Interstate Electronics, Inc.
PDA-500, 14 X 14.75 X 6.50", 512 X 512 pixel, 49 lbs., 40W
PDA-600, 14 X 8.5 X 6.25", 256 X 512 pixel, 29 lbs., 35W

Thomson-CSF (European Military Markets)
TH-7606, 335 X 335 90mm, 512 X 512 pixel, 8kg, 64W
TH-7603A, 260 X 260 X 60mm, 256 X 256 pixel

Non-militarized AC plasma screen:
Plasma Graphic Corp.
120 Display, 6.52 X 11.2 X 1.4", 480 X 250 pixel, 3 lbs., 20.5

Although Electro-luminescent displays have not yet been ruggedized, it has been recommended by experts for future applications because of its durable, solid-state construction, light weight and cost.

Sharp Electronics Corp.
LJ-320U01, 148.5 X 178.5 X 34mm, 320 X 240 pixel, 0.6kg, 8.5W

Vacuum flourescent displays are also a viable option.

Digital Electronics Co.
G320 X 240, 8.52 X 8.2 X 2.33", 320 X 240 pixel, 37.5W
G256 X 256, 4.02 X 4.02", 256 X 256 pixel, 37.5W

6.2 SPEECH SYNTHESIS

Voltrax, Inc. has two text-to-speech systems.
"Type 'N Talk", 8 X 5 X 3, 2 lbs., $300
"Personal Speech System", 12 X 5 X 3, 2.6 lbs., $400
Voltrax uses Texas Instrument's speech synthesis chips.

Standard Micro Systems Corp. presently makes cheap speech synthesis products for microcomputers.

"PC-Talke" board (for IBM-PC) $200

Unlimited, phonemic based speech, uses Votrax Inc.'s SC-01 LSI device.

Microvoice Systems Corp.

"Microsound", 11 X 6 X 3", 4 lbs.

Complete vocabulary is stored in host computer. $1300, quantity discounts available.

6.3 VOICE RECOGNITION

All speaker trained products currently on the ~~marked~~ offer about 98% accuracy.

Intersate Voice Products

Model VRC008 chip, $18.45 + tooling, quantity discounts available. Sixteen word vocabulary, speaker independent, 90% accuracy.

Model VRC100-2 chip set, $385, quantity discounts available. Two Hundred word vocabulary, speaker trained, 99 + % accuracy.

Scott Instruments

Shadow/Vet, 1.3 X 6 X 9", 3 lbs., $595

Vet - 2, $795

Both can recognize 40 words. Add-ons can increase capacity by 40 words each.

Hycom

12 X 12" board, 50 utterances, $3,000.

Honeywell has done work in voice recognition and speech synthesis, using VOTAN's products, for it's VIMAD system.

6.4 MASS STORAGE

The following two companies offer non-militarized optical disk systems:

Panasonic

TQ2021, 8" disk, 21 X 8 X 18" 57.2 lbs., 15k frame capacity

Present costs: disk - $525, drive - $18,900

Thomson-CSF

GD1001, 12" disk, 1Gbyte capacity

Present costs: disk and drive - $6,000 to $9,000

Panasonic and RCA are working on ruggedizing the drives. Whether they are successful or not has yet to be determined. The 3M company has been recommended for supplying optical media.

Drexler Technology manufactures the optical cards.

Credit-card sized card, 4Mbyte capacity

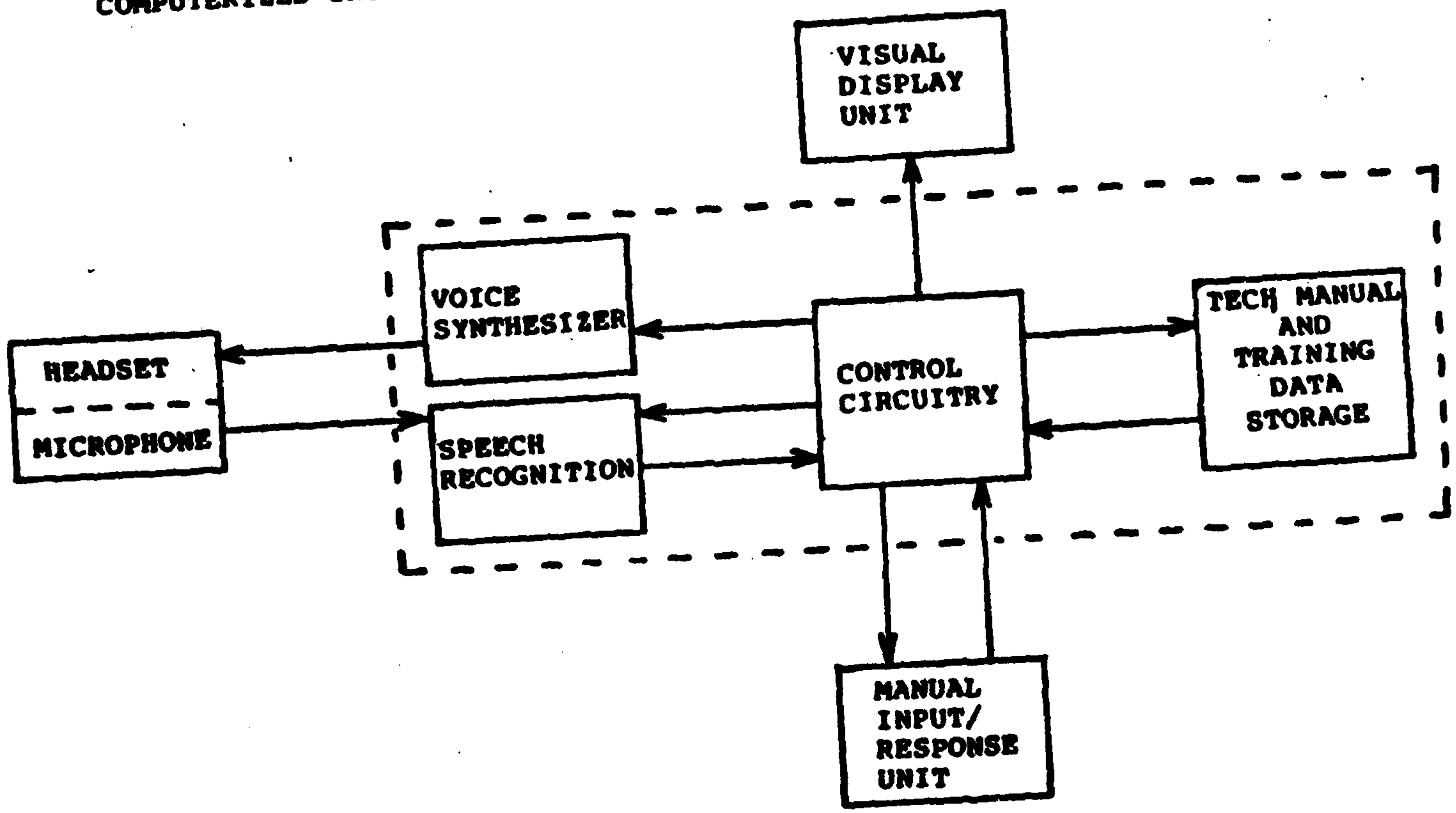
Card $1.50 each, costs predicted to late 1984.

Read-only drive $100

Read/Write drive $500

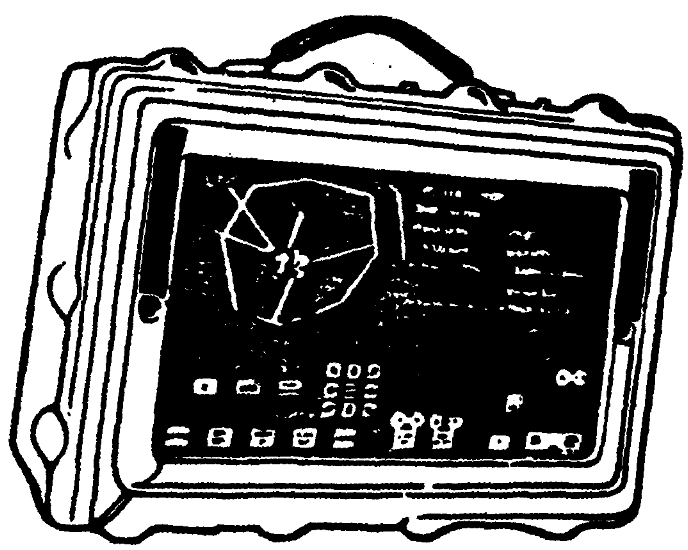
Honeywell has been licensed to manufacture the readers for the cards.

COMPUTERIZED INTERACTIVE TECH DOCUMENTATION & TRAINING SYSTEM



BLOCK DIAGRAM

FIGURE 1



FLAT PANEL DISPLAY

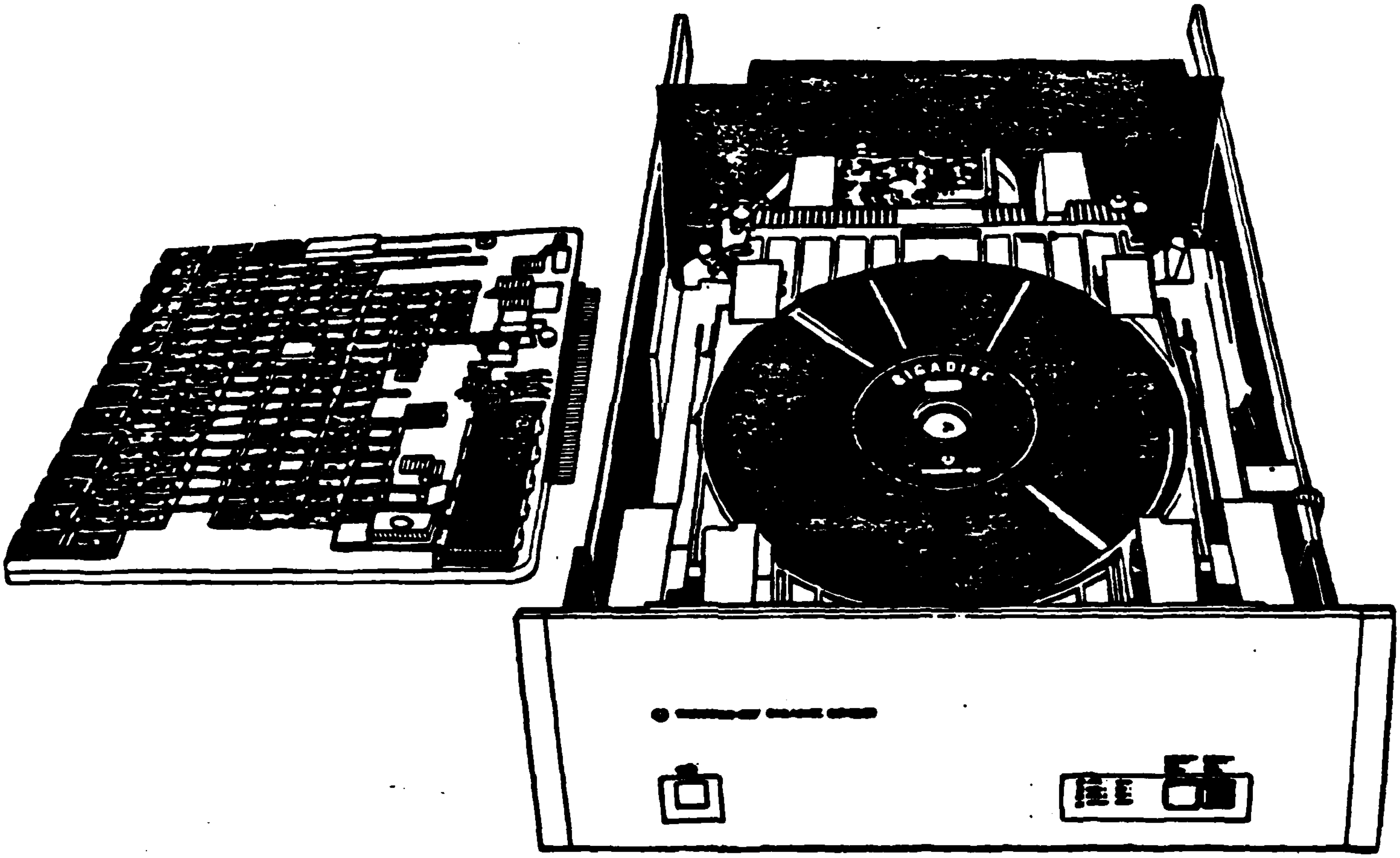
FIGURE 2

FLAT PANEL DISPLAY

FIGURE 2

HELMET MOUNTED DISPLAY

FIGURE 3



DIGITAL DISK DRIVE

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ADDENDUM 8

CECOM Comments on Requirement for Utilization of ADA with MCDP

DEPARTMENT OF THE ARMY
PROGRAM MANAGER, TEST MEASUREMENT AND DIAGNOSTIC EQUIPMENT (TMDE)
FORT MONMOUTH, NEW JERSEY-07703

REPLY TO
ATTENTION OF:

AMCPM-TMDE-S

6 NOV 1984

SUBJECT: Joint Working Group held at TACOM for the MI Tank's Maintenance Control and Display Panel (MCDP)

Commander
US Army Tank-Automotive Command
ATTN: AMSTA-RGDD (J. Steyaert)
Warren, MI 48090

1. As a result of the Joint Working Group (JWG) held by Joe Steyaert, ATSS was asked to determine if 1812 OP Code can be used for the Engine Monitor Module (EMM) for the MI Tank.

2. In response to the task, as per DOD 5000.31, 1812 OP Code can be used with the INTEL8088 Chip, the current firmware for the EMM, if the source code is a Higher Order Language (HOL). The 1812 OP Code cannot be used if it is company proprietory and/or the source code is company proprietory or if the source code is an assembly language.

3. For further information for this task, the POC is Lou Zanelli, CECOM, AMCPM-TMDE-S, Fort Monmouth, NJ; phone: AV 992-2191, commercial (201)532-2191.

DOUGLAS H. BARCLAY
Colonel, OrdC
Program Manager
Test, Measurement and
Diagnostic Equipment

Addendum 9

Log R & D Funding Availability Assessment

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA. 22333

AMCDE-SG 26 OCT 1984

SUBJECT: Concepts for Maintenance and Control Display Panels (MCDPs)

Commander
US Army Tank Automotive Command
ATTN: AMSTA-RGD
Warren, MI 48090

1. Reference:

a. Joint Working Group (JWG) meeting on MCDPs at TACOM, 17-18 Oct 84.

b. Message, HQ AMC, AMCDE-PII, 121610Z Oct 84, subject: Reduction of RAM-D Support Costs (Enclosure 1).

2. At the referenced JWG meeting HQ AMC was tasked to investigate the feasibility of using Logistics Research and Development (LOG R&D) funding for development of MCDP concepts. Based on preliminary inquires it appears that LOG R&D funding is not a feasible solution for the near term funding requirements.

3. There is currently no separate Army Log R&D funding. All ongoing LOG R&D efforts are currently being funded from resources already allocated to the applicable subordinate command laboratories and program managers. For FY86 OSD has created and controls a pool of $50M to fund LOG R&D initiatives submitted by all DOD components. The Army has already submitted a consolidated prioritized list of projects to compete for a share of this $50M fund. OSD is currently holding hearings to review the services input. It is doubtful that OSD would consider a late submission for MCDP funding if a formal MCDP program is initiated.

4. One of the Army projects under consideration by OSD is a 6.2 effort for conceptual definition of generic On Board Test (OBT) equipment that would be applicable to a wide variety of systems. While it appears that this effort, to be conducted by the Armament Research and Development Center, is not directly applicable to a 6.4 MCDP program the ARDC proponents for the OBT effort should be kept informed of the progress of the MDCP program.

5. Reference b is AMC's implementation plan for the VCSA's initiatives to reduce system O&S costs and improve operational readiness rates. The M1/M1A1 tank is one of the systems specifically targeted for these initiatives. It appears that a MCDP would be a leading contender for the M1 to reduce O&S costs and provide a predictive failure capability. Request that information developed by the MCDP JWG be furnished to the office at TACOM that is preparing the response to reference b.

6. The POC at this HQs is Mr. Gene Duncan at Autovon 284-9870.

1 Enclosure
as

PHILIP L. YEATS
Colonel, GS
Ground Combat Systems Division
DCS for Development, Engineering
and Acquisition - Systems
Management

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FROM: //AMCDE-PII//

TO //AMSTA-CG//

//AMSAV-G//

//AMSMI-X//

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//AMSEL-CG//

//AMDEL-CG//

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//AMCPM-CAM//

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INFO

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DISTR:

DRAFTER TYPED NAME

COL GEORGE ROSTINE, AMCDS-P, X49348

12 OCT 84

TYPED NAME, TITLE, OFFICE SYMBOL

GEORGE W. ROSTINE, COL, CS, AMCDS-P, 49348

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DD FORM 173/2

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BOOK · MESSAGE HANDLING INSTRUCTIONS

FROM: DIRETDL FT MONMOUTH NJ //DELET//

TO: DIREWL FT MONMOUTH NJ //DELEW//

CDRHDL ADELPHI MD //DELHD//

DIRNVEOL FT BELVOIR VA //DELNV//

DIRSWL VINT HILL FARMS WARRENTOWN VA //DELSW//

DIRRTL MOFFETT FIELD CA //SAVDL//

CDRAVRADA FT MONMOUTH NJ //SAVAA//

CDRLCWSL DOVER NJ //AMSMC//

CDRFC&SCWSL DOVER NJ //AMSMC//

UNCLAS

SUBJECT: REDUCTION OF RAM-D SUPPORT COSTS (S: 16 OCT 84)

A. AMC LTR, AMCQA, SAB, DATED 5 OCT 84.

1. THE PURPOSE OF THIS MESSAGE IS TO INSURE AWARENESS OF THE AMC COMMUNITY OF RECENT DIRECTION BY THE VCSA TO REDUCE SYSTEM O&S COSTS AND IMPROVE OPERATIONAL READINESS RATES, TO ACQUIRE MSC AND SELECTED PMO POINTS OF CONTACT FOR IMPENDING AMC EFFORTS, AND TO ADDRESS MANAGEMENT OF AMC'S PARTICIPATION. ALTHOUGH THE VCSA'S DIRECTION IS SPECIFIC, AMC'S EFFORTS TO IMPLEMENT IT WILL LIKELY REQUIRE PARTICIPATION OF MORE AMC ELEMENTS THAN IS READILY APPARENT AT THIS TIME.

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MESSAGE FORM

UNCLASSIFIED

ORIG/MSG IDENT

2816002

...ESTABLISHED FY91 GOALS FOR REDUCTION OF SYSTEM RAM-D
...COSTS AND NOR RATES FOR 10 SELECTED WEAPONS SYSTEMS.
...TO ODCSRDA IS QUOTED BELOW.

...CONTINUED TO PROCURE AND FIELD MODERN EQUIPMENT, WE
...RESEARCH AND DEVELOPMENT EFFORTS TO SUBSTANTIALLY
...CHARACTERISTICS OF THIS EQUIPMENT AND REDUCE THE
...COSTS.

...CURRENT ESTIMATES, SOME OF THE FOLLOWING SYSTEMS
...RAM-D COST DRIVERS FOR FY86 - FY91.

F. CH-47D

...TANK) G. PATRIOT

H. PERSHING II

I. MULTIPLE LAUNCH ROCKET

...ING VEHICLE SYSTEM SYSTEM (MLRS)

...SUM J. AHIPS

...EQUIPMENT ... ... COMMUNICATIONS

...ANALYSIS.

...ISTED BY ... AND ..., TO CONFIGURE OUR

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MESSAGE HANDLING INSTRUCTIONS

RESEARCH AND DEVELOPMENT PROGRAM (BOTH CONTRACT AND IR&D) TO REDUCE THE FY91 RAM-D DRIVEN SUPPORT COSTS OF THESE SYSTEMS BY 50 PERCENT. AT THE SAME TIME, DECREASE THE NOR RATE 50 PERCENT. FOR EXAMPLE, THE CH-47D REQUIRES 19 MAINTENANCE HOURS TO 1 FLYING HOUR. LET'S CUT THIS IN HALF BY 1991. TO GET STARTED, IT SEEMS THAT THE FOLLOWING SHOULD BE ACCOMPLISHED, AS A MINIMUM:

A. LAY OUT THE COSTS FOR EACH SYSTEM IN ORDER BY TOTAL SUPPORT COSTS (INCLUDING PERSONNEL, TRAINING, SPARES, DEPOT MAINTENANCE, ETC.), BY YEAR FOR FY85-FY91.

B. FOR EACH SYSTEM, IDENTIFY THE TOP TEN COMPONENTS DRIVING THE RAM-D SUPPORT COSTS.

C. IDENTIFY RAM-D SUPPORT COST DRIVERS THAT ARE COMMON TO SEVERAL SYSTEMS.

D. LAY OUT ALL CURRENT R&D PROJECTS, CONTRACT AND IR&D, ADDRESSING THESE COST DRIVERS AND PROPOSE PROJECTS TO FILL THE GAPS. THESE PROJECTS MUST BE STRUCTURED TO YIELD FIELDED RESULTS ASAP, BUT NO LATER THAN FY91. YOUR GOALS SHOULD BE SIGNIFICANT REDUCTIONS IN: EQUIPMENT DOWN-TIME, MAINTENANCE SUPPORT STRUCTURE, TRAINING REQUIREMENTS AND DOLLAR COSTS. ADDITIONALLY, A PREDICTIVE FAILURE CAPABI-

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MESSAGE HANDLING INSTRUCTIONS

B. PM-AAH AND CDR, AVSCOM COORDINATE AAH DATA INPUT TO AMC.

C. ADDRESSEES REPORT A MSC POC AND A PMO POC FOR EACH WEAPON SYSTEM DESIGNATED BY VCSA TO THIS HEADQUARTERS, CHARLIE ROCK, AMCDE-PI, AUTOVON 284-9200, BY COB 16 OCT 84.

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SPECIAL INSTRUCTIONS

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Addendum 10

Contract Administrative Lead Time Estimate

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGO

REFERENCE OR OFFICE SYMBOL	SUBJECT
AMSTA-IRR	Contract Administrative Lead Time Estimate for Inclusion in Report for AMC

TO	FROM	DATE	CMT 1
WSM, Dg & Elec (AMSTA-RGD)	C, Rsch, Dev & Engr Proc Br A (AMSTA-IRR)	27 NOV 1984	Mr. Szymczak/pk/46381

1. Reference your DF dated 16 Nov 84, SAB.

2. Proper response required background of the program, which was provided by Mr. J. Steyaert of your office.

3. There are annually published PALT Standards, a copy for FY 85 is enclosed for your information.

4. As a result of the discussion with Mr. Steyaert, it was learned that there are two key ingredients of this program; namely, (a) the dollar value and (b) existance of competition which will govern the PALT. In our opinion, a "most likely to award" schedule is the only one which should apply as the development of a minimum/maximum schedule would be the establishment of unrealistic dates. It must be emphasized that the schedule is ambitious and demands a "dedicated team" effort to successfully attain the target.

5. Enclosed is the projected PALT Schedule for the Maintenance Control and Display Panel Program.

E L Szymczak

E. L. SZYMCZAK
C, Rsch, Dev & Engr Proc Br A

2 Encl
as

CONCURRENCE: R Marttila

R. MARTTILA
C, Rsch, Dev & Engr Proc Div

DA FORM AUG 80 2496 PREVIOUS EDITIONS WILL BE USED

U.S. Government Printing Office: 1983—406-61

Directorate For Procurement and Production

INFORMATION LETTER

NUMBER : 123-84 * **DATE :** 26 Oct 84

FY85 PALT STANDARDS

1. This letter is issued to advise Contract Specialists for FY85.

2. This letter applies to all Contract Specialists in the Directorate for Procurement and Production.

3. The FY85 PALT Standards are as follows:

CODE	PROCUREMENT METHOD	PALT STANDARD (DAYS)
S	Small Purchase-Competitive Negotiation (for DD Form 1155 Awards)	105
T	Small Purchase-Noncompetitive Negotiation (for DD Form 1155 Awards)	95
1	Formal Advertising	165
2	Two-Step Formal Advertising, Step One	180
3	Competitive Negotiation (for awards other than DD Form 1155)	$25,000 & under - 105 Over $25,000 - 180
4	Negotiated Sole/Limited Source (for awards other than DD Form 1155)	$25,000 & under - 95 Over $25,000 - 185
5	Noncompetitive Negotiation resulting from follow-on action after price, design, or technical competition (for awards other than DD Form 1155)	$25,000 & under - 85 Over $25,000 - 135
6	Government-owned contractor-operated (GOCO) plant; noncompetitive negotiation	N/A
7	GOCO plant; competitive negotiation	N/A
8	Government-owned, Government-operated (GOGO) plant	N/A
9	Military Interdepartmental Purchase Request (MIPR)	N/A

*Supersedes IL 123-84 dated 23 Oct 84

INFORMATION LETTER: 123-84 DATE: 26 Oct 84

CODE	PROCUREMENT METHOD	PALT STANDARD (DAYS)
A	Option Exercised (must be accompanied by PWD Status Code A1, A3, or A4)	30
D	Call/Delivery Order	70
F	Two-Step Formal Advertising, Step Two	N/A

GILBERT J. KNIGHT
C, Proc Anal & Compl Div

DISTRIBUTION:

C, E-1, E-5, AMSTA-FPCA

(Proj. No. 789-84, THM)

27 Nov 84

MAINTENANCE CONTROL AND DISPLAY PANEL PROGRAM

Prior to release of solicitation documents, required are approved:
Acquisition Plan
Secretarial Determination and Findings

PALT SCHEDULE *

Action	Calendar Days
Commerce Business Daily Notice (Public Law 98-72) RFP preparation, Staffing, Legal Review, Boards	35
Proposal Submission	45
Audit, Technical Fact Finding, Cost Analysis, Evaluation, Negotiations, Best and Finals	60
Reviews, Approvals, Boards	12
Congressional Press Release/Award	2
	154

*Groupings reflect concurrent actions. PALT starts with receipt of complete procurement package.

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Addendum 11

Impact of MCDP on Component NEOF

IMPACT OF MCDP ON COMPONENT "NEOFS"

Installation of the MCDP in the hull for engine system diagnostics and in the turret for fire control system diagnostics will produce significant improvements in the diagnostic accuracy, over the present organization level troubleshooting methods.

An indication of the cost effectiveness of the MCDP may be obtained by estimating the attendant reduction in No Evidence OF Failure (NEOF) among those LRUs monitored by the MCDP. Recent studies of the twelve most misdiagnosed LRUs (attached chart) as determined at the Direct Support level show that the average NEOF level is approximately 50%.

Conservatively, implementation of MCDP will reduce the NEOFs to less than 25%. (Cut the NEOF level in half) in the near term. With further fine tuning of the MCDP diagnostics and supplemental manual procedures after the units are installed on vehicles, the NEOFs could be reduced to less than 10%, or equivalent to an overall diagnostic accuracy of 90%.

Based on considerable knowledge and experience with both engine and fire control system failure modes, causes, and diagnostic methods the projected accuracies for detecting faulty components with MCDP are provided in the following table:

FAILURE MODE GROUP/ POPULATION	MCDP DIAGNOSTIC CAPABILITY TO AMBIGUITY GROUP	ESTIMATED ACCURACY TO AMBIGUITY GROUP	ESTIMATED ACCURACY TO IDENTIFY FAULTY COMPONENT WITHOUT FURTHER ISOLATION (1)	FURTHER ISOLATION REQUIRED	ESTIMATED ACCURACY TO IDENTIFY FAULTY COMPONENT WITH FURTHER ISOLATION (2)	TOTAL ACCURACY OF FINDING FAULTY COMPONENT USING MCDP AND FURTHER ISOLATION
1 50%	SINGLE COMPONENT	95%	95%	NO	N/A	95%
2 25-35%	TWO COMPONENTS	95%	80%	YES	90%	90%
3 15-25	THREE COMPONENTS	95%	50%	YES	75% (3)	75% (3)
100%						

(1) ASSUMES THAT MCDP WILL PROVIDE MAINTENANCE PERSONNEL WITH A PRIORITIZED LIST OF THE MOST PROBABLE FAILED COMPONENTS WITHIN EACH AMBIGUITY GROUP.

(2) FOLLOW-ON TROUBLESHOOTING PROCEDURES USING SIMPLE TOOLS SUCH AS A MULTIMETER OR BREAKOUT BOX AND SIMPLE MANUAL PROCEDURES.

THE RESULTANT ACCURACIES IN COLUMN "B" AND COLUMN "C" FOLLOW FROM EXPERIENCE WITH ALTERNATE TROUBLESHOOTING PROCEDURES (ATP´S) WHERE THE ACCURACY IN IDENTIFYING THE FAULT COMPONENT WITHIN THE RESIDUAL INACCURACY IS CONSERVATIVELY ESTIMATED AT 50%. THIS IS CONSISTENT WITH PRESENT FIELD DATA USING MANUAL ISOLATION AND INCLUDES EFFECTS OF OPERATOR ERROR.

THEREFORE, THE 90% ACCURACY NUMBER IN LINE 2, COLUMN "B" IS A RESULT OF TAKING 50% OF THE RESIDUAL 20% INACCURACY IN COLUMN"A" AND THENM ADDING THE PRODUCT. (10%), TO THE 80% ACCURACY OF COLUMN "A"/

(3) ACCURACY LIMITED DUE TO LIMITED TEST CAPABILITY OF SIMPLE TOOLS. APPLIES IN LESS THAN 7% OF ALL FAILURE SYMPTOMS.

COMPONENTS SAMPLED*

1. COMPUTER CONTROL PANEL (CCP)
2. GUN TURRET DRIVE ELEC. UNIT (GTD - EU)
3. TURRET NETWORKS BOX (TNB)
4. DRIVER'S MASTER PANEL (DMP)
5. COMPUTER ELEC. UNIT (CEU)
6. HULL NETWORKS BOX (HNB)
7. LASER RANGEFINDER (LRF)
8. LINE OF SIGHT ELEC. UNIT (LOS - EU)
9. ELECTRONICS CONTROL UNIT (ECU)
10. HULL DISTRIBUTION BOX (HDB)
11. DRIVER'S INSTRUMENT PANEL (DIP)
12. CDRS. WPN. STA. PWR. CNTRL. UNIT (CWS - PCU)

* RANKED IN ORDER OF MISDIAGNOSIS

Addendum 12

Glossary of Acronyms

GLOSSARY OF ACRONYMS

AARMC	Army Armor Center
AMC	Army Materiel Command
ATEPS	Advanced Techniques for Electrical Power Management, Control and Distribution System.
AVSCOM	Aviation Systems Command
BIT	Built-in Test
BITE	Built-in Test Equipment
BMS	Battlefield Management System
CCP	Commanders Control Panel
CECOM	Communication & Electronics Command
CITV	Commanders Independent Thermal Viewer
CMPES	Chrysler Military-Public Electronic Systems
DECU	Digital Engine Control Unit
ECU	Engine Control Unit
EMM	Engine Monitor Module
GDLS	General Dynamics Land Systems Division
GTD-EU	Gun Turret Drive Electronics Unit
HNB	Hull Networks Box
JWG	Joint Working Group
LRU	Line Replaceable Unit
MCDP	Maintenance Control and Display Panel
NEOF	No Evidence of Failure
OBT	On-board Test
ORDCENSCH	Ordnance Center and School
PCB	Printed Circuit Board
PEP	Producibility Engineering & Planning
Set Com	Set Communicator (a soldier/ machine interface device)
STE	Simplified Test Equipment
STE/ICE	Simplified Test Equipment for Internal Combustion Engines
STE-M1/FVS	Simplified Test Equipment for the M1 Tank and Bradley Fighting Vehicle
STE-X	Simplified Test Equipment-Expandible
TACOM	Tank-Automotive Command
TMM	Turret Monitor Module
TNB	Turret Networks Box
TRADOC	Training and Doctrine Command
TST	Turret Stabilization Terminal
VMM	Vehicle Monitor Module
VMS	Vehicle Monitor System

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